A Heuristic Algorithm for Optimizing Business Matchmaking Scheduling

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ABSTRACT

Business matchmaking is a service dedicated to providing one-on-one appointments for small businesses (or sellers) to meet with government agencies and large corporations (or buyers) for contracting opportunities. Business matchmaking scheduling seeks to maximize the total number of appointments with the maximum objective that weighs the preferences of both buyers and sellers. In this paper, the authors transformed the business matchmaking scheduling problem into a 3-dimensional planar assignment problem and solved it heuristically using a series of bipartite maximum weighted maximum cardinality matching problems. Simulation experiments and real data showed that this algorithm outperforms human experts and prior algorithms in terms of number of appointments, the objective that weighs buyer and seller’s preferences, and the execution time.

Keywords: Algorithm, Business Matchmaking, Buyers, Heuristic Algorithm, Scheduling Optimization, Sellers, Small Businesses

INTRODUCTION

A small business, in general, is a business that (1) is independently owned and operated, (2) is not dominant in its field of operation, (3) has annual revenue under $500,000, and (4) has fewer than 500 employees (U.S. Small Business Administration, see at http://www.sba.gov). Small businesses are major job providers and the engine for economic growth in the United States and around the world. Business matchmaking events provide a unique opportunity for small businesses (or sellers) to present product and service solutions to government agencies and large corporations (or buyers) for contracting opportunities through pre-scheduled, one-on-one, and face-to-face appointments with procurement representatives (Business Matchmaking, see at http://www.businessmatchmaking.com).

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One major goal of scheduling a business matchmaking event is to produce as many appointments as possible, thus to create more procurement opportunities, and therefore more job opportunities that provide a stimulus for economic growth. Currently, many business matchmaking scheduling tasks are accomplished semi-manually by human experts using spreadsheet software, such as Microsoft Excel. This semi-manual process can only handle a small input size (i.e., a small number of buyers and sellers), and is tedious and time-consuming, and often leads to sub-optimal and conflicting schedules. Efforts have been made to automate this semi-manual process through computer programs. These programs, however, usually fail to generate the maximum number of appointments. Therefore, a more effective algorithm is needed to improve the quality of business matchmaking scheduling.

Scheduling is a well-studied topic in science, engineering, and business. The following is a brief review of the empirical studies that are closely related to the current one. Gilbert and Hofstra (1987) presented a polynomial algorithm to solve the three-index planar assignment problems provided their objective functions are invariant with regard to one dimension. Montoya-Torres, Gómez-Vizcaíno, Solano-Charris, and Paternina-Arboleda (2010) examined the problem of jobshop scheduling with either makespan minimization or total tardiness minimization. Hertz and Robert (1998) considered a constraint-based course scheduling problem and proposed a heuristic method that decomposes the problem into a series of assignment sub-problems. Our paper uses a similar idea to partition the optimization problem into a series of matching problems. Das (2009) proposed a model to solve the airport gate assignment problem with some side constraints such as “fixing or prohibition of flights in a particular gate due to restriction imposed by certain airline, adjacent gate restriction due to some technical constraint, and adjacent gate push time restriction” (p. 315). Moeeni, Chan, and Replogle (2011) proposed an efficient, stage-wise optimization model for scheduling part-time staff. They used three separate case studies to illustrate that their stage-wise model “has the necessary flexibility and computational efficiency to solve many real-world business scheduling problems” (p. 52).

Willoughby and Zappe (2006) used a method to optimize foundation seminar assignments in an attempt to determine assignments that better satisfy the highest preferences of the students. Furthermore, scheduling has been studied in a number of similar problems, such as the scheduling of sports competitions on multiple venues (Urban & Russel, 2003), scheduling medical residents to rotations (Franz & Miller, 1993), assigning students to groups (Weitz & Jelassi, 1992), assigning conference papers to reviewers (Hartvigsen, Wei, & Czuchlewski, 1999), scheduling appointments at trade events (Ernst, Mills, & Welgama, 2003), rescheduling unrelated parallel machines under machine breakdowns (Arnaout & Rabadi, 2008), and scheduling staff weekly when movement restrictions exist between workstation groups (Wan & Bard, 2007).

In this paper, the quality of a schedule is measured by the number of appointments produced, the objective that weighs buyers’ and sellers’ preferences, and the execution time. We transformed the business matchmaking scheduling problem into a 3-dimensional assignment problem and then solved it heuristically using a series of bipartite maximum weighted maximum cardinality matching problems.

A major contribution of this paper is the presentation of an effective algorithm for solving an important practical problem. Our proposed algorithm outperforms human experts and the prior algorithm in terms of the number of appointments scheduled, the objective that weighs buyer and seller’s preferences, and the execution time.

The rest of the paper is organized as follows. We first describe the background of business matchmaking and the prior algorithm for scheduling business matchmaking appointments. Then we go on to formulate an optimiza-
Multi Depot Probabilistic Vehicle Routing Problems with a Time Window: Theory, Solution and Application
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