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Controlling algorithmic blocking: Calibration and Cost Redistribution approach to real-world operational railroad application

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ABSTRACT

While algorithmic blocking has been shown to have significant advantages over a traditional, tag table approach for the operational implementation of a freight railroad's blocking plan, railroads have been reluctant to pursue that approach, partly due to the perception that algorithmic blocking is difficult to control. Control refers to configuring the data underlying algorithmic blocking so that block paths returned for rail car movements are those desired by railroad management. This paper presents three complementary control strategies—Every Day, Calibration and Block Cost Redistribution—which together provide a practical way to achieve control with algorithmic blocking. The paper also includes a comprehensive description of an implementation of algorithmic blocking upon which these control strategies are based.

1. Introduction

In the parlance of freight railroading, a *block* is a group of cars physically connected and transported together for a portion of the cars' individual journeys. A block is assembled at the block's origin yard in a labor-intensive and time-consuming sorting process known as *classification*. A block formed through classification is subsequently transported by one or more *trains* to the block's destination yard. Trains carry rail cars, but more correctly, trains carry blocks. An individual rail car moves from its origin to its destination in a series of blocks referred to as a *block path*, the basis for the car's itinerary. Blocking reflects the fact that a railroad functions as a hub-and-spoke and not as a point-to-point transportation system. In this hub-and-spoke system, the relative efficiency of an individual rail car movement might be measured by three metrics—number of classifications, total distance and total time.

An example rail car movement is shown in Fig. 1. A boxcar is to be moved between classification yards S and T through a network consisting of yards as nodes and blocks as arcs. Among possible paths from S to T, one is labeled as the block path to be used for this movement.

Railroads utilize *blocking systems* to capture *blocking plans* and to implement blocking decisions. Given locational, shipment and other attributes of a rail car to be moved, a blocking system returns either the next block from the rail car's current location or the entire block path to the rail car's destination. The most commonly used blocking system, known as *tag tables*, uses if/then business rules to determine the next block. In 1994, Norfolk Southern Railroad adopted an alternative approach, known as *algorithmic blocking*, which combines business rules with the shortest path algorithm.

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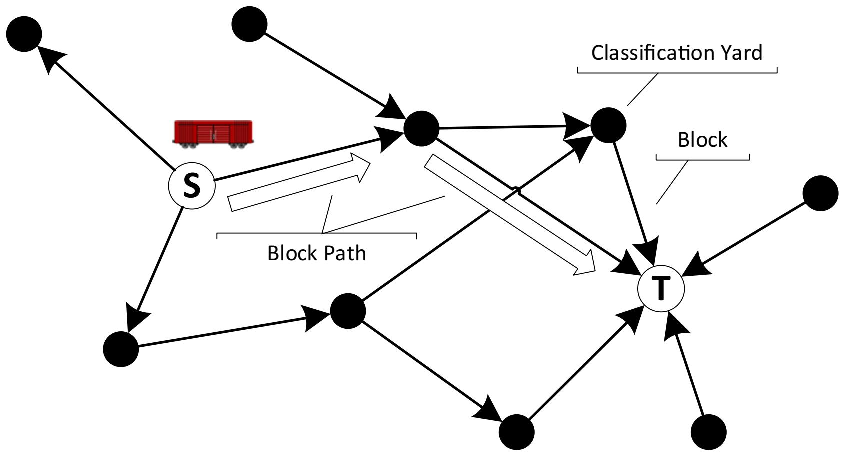

Fig. 1. Rail car movement path example.

Norfolk Southern has demonstrated that an algorithmic blocking system enjoys significant advantages over tag tables with respect to the amount of effort required to maintain the system and the rapidity with which plan changes can be made (Van Dyke and Meketon, 2015). For example, with algorithmic blocking, Norfolk Southern required only one person-hour to reroute hazardous material shipments around Atlanta during the 1996 Olympic Games, while another railroad, which utilized tag tables, required six months to accomplish the same task (Baugher, 2007). These advantages exist for two reasons. First, tag tables must explicitly reference the thousands of potential destinations for rail car movements, whereas algorithmic blocking does so implicitly. Second, tag tables require careful coordination of rules between yards to achieve block paths that make sense, whereas algorithmic blocking generates block paths from a network perspective through a combination of business rules and shortest paths.

Other North American railroads have been slow to adopt algorithmic blocking. While Canadian Pacific began using the Norfolk Southern blocking system in the late 1990s, CSX adopted algorithmic blocking only in 2015, while BNSF is only now investigating algorithmic blocking. Cost and integration issues may well be among the reasons for this slow rate of adoption, but so too has been the perception that "algorithmic blocking can be more challenging to manage, and the user may have less control over the routing of specific shipments" (Van Dyke and Meketon, 2015).

As shown in Fig. 2, tag tables provide a high level of control, but score low on maintenance effort and agility (the ability to update the blocking plan quickly). On the other hand, algorithmic blocking scores high on maintenance effort and agility, but scores lower for control. The purpose of this paper is to address this control challenge by presenting practical ways to achieve desired routings for individual rail car movements by manipulating the business rules and costs underlying algorithmic blocking in a systematic fashion, thereby achieving a marked improvement in the control dimension.

The remainder of this paper is organized as follows. Section 2 reviews existing literature related to algorithmic blocking. Section 3 describes an implementation of algorithmic blocking as a lead up to Section 4, which explains three complementary control strategies. Section 5 presents experimental results while Section 6 provides conclusions and suggestions for future research.

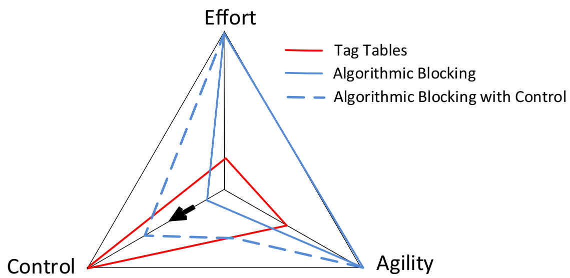

Fig. 2. Comparison of approaches to implement blocking.