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A Comparison between Gradient Projection Methods For Traffic Assignment Problem

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Abstract

Recently, gradient projection (GP) has been extended as efficient algorithms for solving the traffic assignment problem (TAP). In this paper, two distinguished GP methods for TAP are investigated. They are an algorithm to apply Bertsekas`s GP method and an algorithm to apply Rosen's GP method. They confront the problem in the same way, but with various descent directions and step sizes.

The efficiency of the algorithms is compared using large-scale test networks. Algorithms are developed in a same platform and compared based on the computational efforts for reaching given accuracies. The results show that the algorithm using Bertsekas`s GP converges more rapidly than another using Rosen's GP.

Keywords: Traffic Assignment, Gradient Projection, Descent Direction Method, Algorithm.

1. INTRODUCTION

The traffic assignment is the last stage of the classic four-stage transportation model. In this stage by solving the Traffic Assignment Problem (TAP) the travel demands between Origin-Destination (OD) pairs are distributed among their paths. For the first time, Wardrop [1] introduced the User Equilibrium (UE) law to explain how the travelers will choose their roots. Afterwards, Beckman et al. [2] proposed an equivalent formulation for the UE which was a minimization problem with a convex objective function. One of the first algorithms for the Beckman's formulation is the Frank-Wolfe (FW) algorithm posed by Leblanc et al. [3], which uses Frank and Wolfe's method [4]. The FW algorithm works based on link flows and finds the descent direction of Beckman's objective function using an all or nothing assignment. This algorithm was the most popular algorithm among the past decades that has been applied in different software packages because of its modest memory usage, tolerable convergence rate in the first iterations and easy implementation.

Besides the FW algorithm, there are several path and origin-based algorithms in the literature that are faster and more effective than the FW algorithm. A path-based FW algorithm has been developed by Chen et al. [5] that is using an acceleration policy to enhance the convergence rate of the original algorithm. A path-based Gradient Projection (GP) Algorithm has been introduced by Jayakrishnan et al. [6]. Another path-based GP algorithm has been proposed by Florian et al. [7]. In addition, Origin-Based Algorithms (OBA) have been introduced by Bar-Gera [8] and have been improved in performance by Dial [9] and Nie [10]. The new algorithms need more memory than FW algorithm but reach the optimal solution in less CPU times. On the other hand, recent advances in computers persuade the researchers and practitioners to use the faster algorithm instead of the slower one. Florian and He [11] noted that not using of the FW algorithm may leads to some change in solutions of the TAP however it causes more accurate solution and less computational efforts. Therefore, applying the faster path and origin-based algorithms in the real life projects and new software packages seems inevitable.

In this paper, two new path-based GP algorithms are numerically compared. These algorithms are those that are developed by Jayakrishnan et al. and Florian et al. In the following sections, TAP is described and the two algorithms are explained. Then, the numerical results are reported and conclusions are mentioned.