On the Basic Vehicle Scheduling Problem*

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Abstract

The vehicle scheduling problem (VSP) is a classical optimization problem of the public transportation. The task is to make the scheduling of the vehicles for a given day, i.e. to serve a feasible and efficient scheduling for each timetabled trips.

In the single depot vehicle scheduling problem (SDVSP) we are given a set of timetabled trips of a given day. Each timetabled trip has a departure and arrival time, departure and arrival geographical points (stations). Each vehicle has the same depot. Deadhead trips are also given, between the depot and the stations, and between two stations. A pair of two timetabled trips is compatible, if there is enough time for the deadhead trip between those. The timetabled trips and the deadhead trips have (non-negative) costs. The problem was solved by Bertossi et al. in 1987 [1]. The authors of [1] showed that SDVSP is equivalent to finding a perfect matching of a complete bipartite graph. Its proof is very elegant and nice.

In the talk we consider an even simpler problem, the so called Basic Vehicle Scheduling Problem (BVSP) when the cost of the SDVSP problem is only the number of needed vehicles. In other words, we are only interested in determining the minimum number of vehicles (each vehicle is assumed to be the same type), which is necessary for serving the (daily) scheduling. BVSP can be interpreted as a special fleet minimization problem as well. We show that the BVSP problem is equivalent to finding a maximum matching of a (non-complete, unweighted) bipartite graph which has around half the possible maximum number of edges. Its proof is also nice in our opinion.

We show two applications of the BVSP problem and solution we dealt with. The first one is to estimate the minimal number of vehicles in arbitrary time-intervals, e.g. dividing a day into equidistant time-intervals of small lengths. The second one is a lower estimation for the working time of a daily vehicle and driver schedule. Instances show that the lower estimation approaches by about 10 percent of a feasible scheduling (where working time considerations and vehicle types are also considered yet).

Keywords: public transportation, Single Depot Vehicle Scheduling Problem, Basic Vehicle Scheduling Problem, fleet minimization, bipartite graph matching

MSC: 90B06, 90B10

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