CHAPTER 80

Quito Metropolitan District

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DMQ (Quito Metropolitan District, Ecuador) has grown rapidly in recent years, with increasing traffic congestion, gas emissions, pollution and energy use. Our research integrated evolutionary computation, traffic simulation, emission models and data mining tools to gain a better understanding of DMQ's complex mobility and transportation system and propose sustainable solutions.

As a first case study (Armas et al., 2014), we implemented a mobility scenario to optimize traffic lights under congested conditions. We focused on the DMQ's business district, an area covering 7x3 square kilometers, as shown in Figure 80.1. The area included only the primary and secondary pathways, where free speeds ranged from 30 to 80 kilometers per hour. The network had approximately 1 000 links and was derived from Geofabrik and OSM. 20 000 agents were simulated, each with a mobility plan consisting of three main trips: (1) home to work, (2) work to leisure and (3) leisure to home (see Figure 80.2). The plans were designed so that all agents moved first from south to north, completely crossing the geographical area of study. In their second trip, the agents moved from north to the central zone of the area under study and in their last trip, from the central zone to the south. Eleven signal lights were located on a main two-way street with flows in south-north and north-south directions (see Figure 80.1).

The evolutionary algorithm (the SOP (Signal Optimizer)) together with MATSim found optimal signal settings of the DMQ scenario, minimizing average travel time. First, we ran MATSim for 500 iterations, to ensure it reached a user equilibrium state without setting any traffic signals. After that, the SOP evolved a candidate solution population for a number of generations. Each solution represented a configuration of signals (signal control) for the transportation system. At each generation, the SOP called MATSim for each candidate solution to evaluate it. MATSim started from the equilibrium state, setting its signals controls with the tentative solution provided by the SOP and ran one additional iteration. This iteration's output was used to calculate travel time, which converted and feed back to the SOP as the fitness value. Figure 80.2 illustrates the

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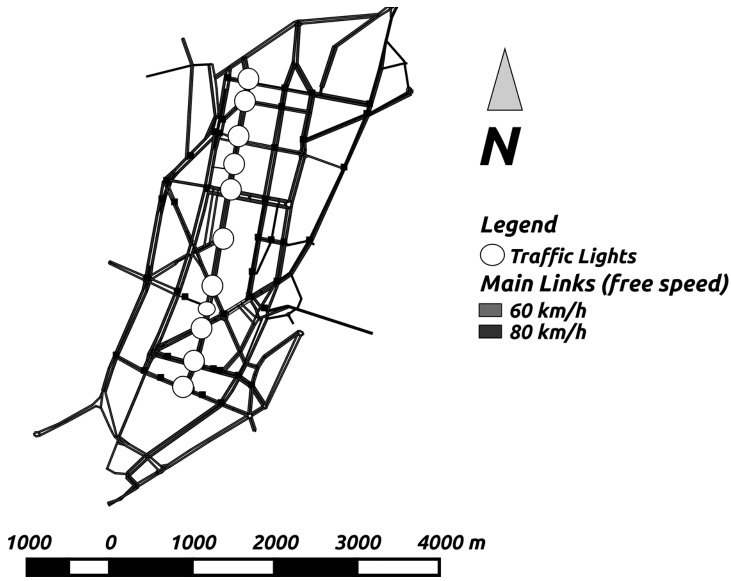

Figure 80.1: Study area.

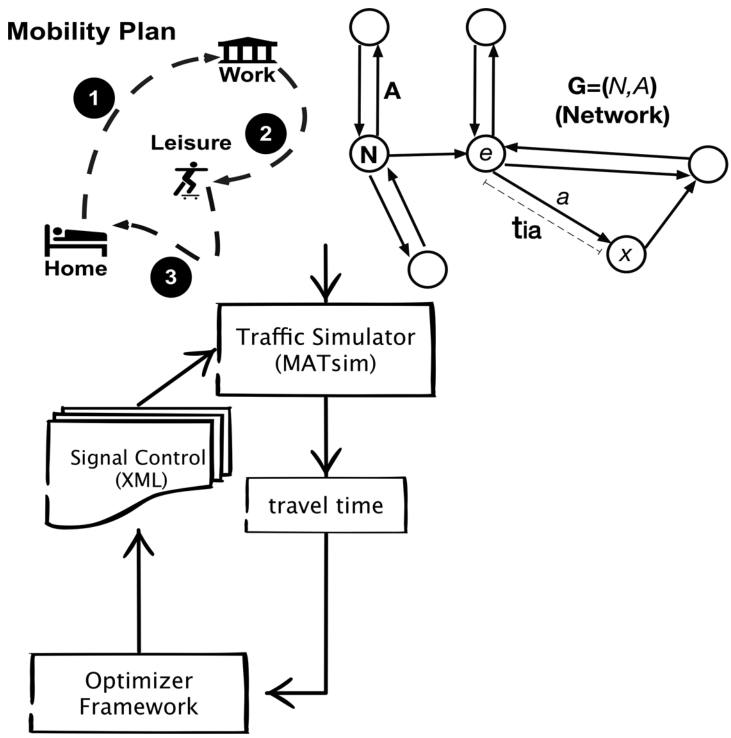

Figure 80.2: Optimization system.

interaction of MATSim and the SOP. The first case study (Armas et al., 2014) provided valuable insights into optimal traffic light setting in the business district of DMQ under congested conditions. This allowed us to validate problem representation used in the SOP and effectiveness of the mutation and recombination operators implemented to search solutions.

Currently, we are scaling up the number of traffic signals to be optimized and testing other mobility scenarios in the same area of study. Our next step is to incorporate an emissions model and use multi-objective evolutionary algorithms (Aguirre et al., 2013) to evolve optimal transportation and mobility system designs of the DMQ, satisfying multiple criteria for sustainability. These criteria include transportation and mobility policies, accessibility, reduction of emissions, reduction of energy use, as well as social and economic benefit.