Showcase 1: Vehicle Refueling Planning

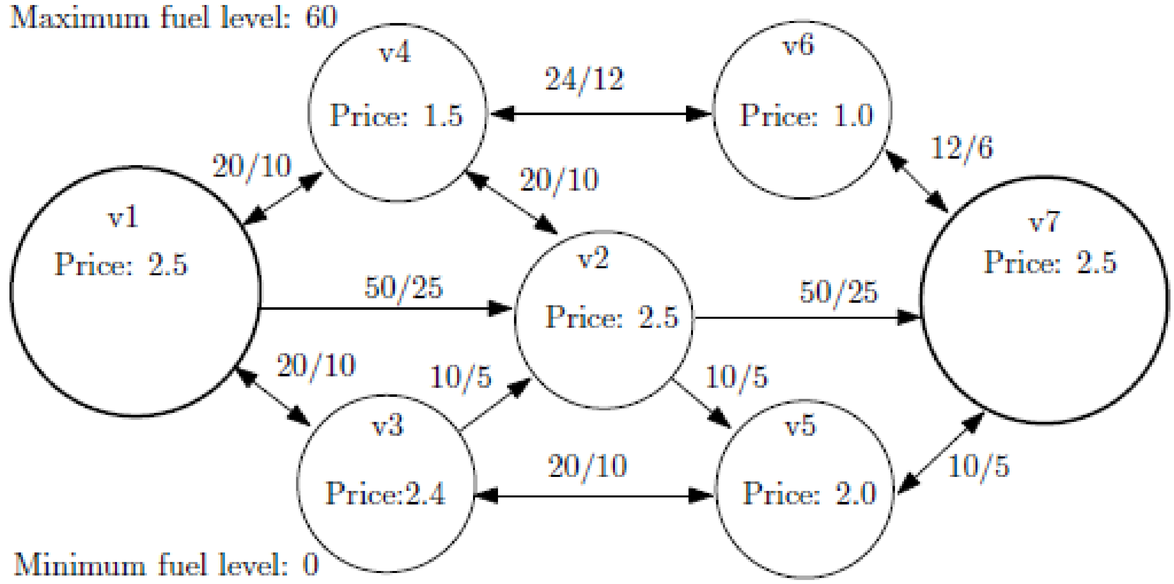

Fig. 1. Vehicle refueling planning in a transportation network

Fig. 1 depicts a multi-objective vehicle refueling instance <*G*, v_1, v_7, ***c***, ***f***, ***t***, *60*>. The transportation network *G* has seven vertices with v_1 and v_7 as the starting point and the destination point respectively. The unit fuel prices c_i per gallon at different locations v_i's range from 1.0 to 3.0. The numbers associated with each directed edge (v_i,v_j) are the amount of fuel consumption $f_{i,j}$ in gallons first and then the travel time $t_{i,j}$ in hours. The amounts of fuel consumption $f_{i,j}$ between vertices range from 10 to 50 gallons while the travel time $t_{i,j}$ between vertices range from 5 to 25 hours. The upper bound of the vehicle fuel level is 60 gallons. This is an instance with linear dependency between fuel consumption and travel time since the travel time $t_{i,j}$ is always 0.5 times the amount of fuel consumption $f_{i,j}$.

For point-to-point delivery of commodity over the transportation network, often the motor carrier sends out a vehicle traveling on the highway for days with a crew of two to take turn in driving. The vehicle needs to stop and refuel along the trip and fuel prices can vary significantly from one fuel station to another in the transportation network. The motor carrier has to devise a vehicle refueling plan that specifies (i) the path from the starting point to the destination, (ii) the intermediate stopping points for refueling along the path, and (iii) the amount of fuel to refill in each stopping point. For the motor carrier, both timely delivery of commodity and reduction of total fuel cost are important objectives to consider in this context.

Planning Task #1: (i) The upper bound of travel time is set to 25 hours. Under the time constraint, the minimal-fuel-cost refueling plan is the refueling path $<v_1, v_3, v_5, v_7>$ together with the refueling vector $F=<20, 20, 10, 0>$ ending in a fuel cost of 118. The total travel time is 25 hours, which is exactly the upper bound allowed. (ii) If the upper bound on travel time is set to 28 instead of 25, then the minimal-fuel-cost refueling plan is the refueling path $<v_1, v_4, v_6, v_7>$ together with the refueling vector $F=<20, 24, 12, 0>$ ending in a much lower fuel cost of 98. The total travel time is 28 hours, which is exactly the upper bound allowed.

Planning Task #2: (i) The upper bound of fuel cost is set to 100. Under the cost constraint, the minimal-travel-time refueling plan is the refueling path $<v_1, v_4, v_6, v_7>$ together with the refueling vector $F=<20, 24, 12, 0>$ ending in the travel time of 28 hours. The total fuel cost is 98, which is below the upper bound of 100 allowed. (ii) If the upper bound on fuel cost is set to 120 instead, then the minimal-travel-time refueling plan is the refueling path $<v_1, v_3, v_5, v_7>$ together with the refueling vector $F=<20, 20, 10, 0>$ ending in a 3-hour reduction of the travel time to 25 hours. The total fuel cost is 118, which is below the upper bound of 120 allowed.