Relating Electric Vehicle Scheduling to Processor Speed Scaling and Network Flow Problems

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Processor Speed Scaling $\subseteq$ Electric Vehicle Scheduling $\subseteq$ Least-majorized Flows

Processor Speed Scaling

Instance

- Jobs j
- Release times r_j
- Deadlines d_j
- Workloads p_j

Decision variable:

- Schedules $s_j(t)$ specify at what speed job j is processed at time t

Feasible solution

- Jobs only process between release r_j and deadline d_j
- Jobs process their entire workload p_j
- Only one job runs at any time t

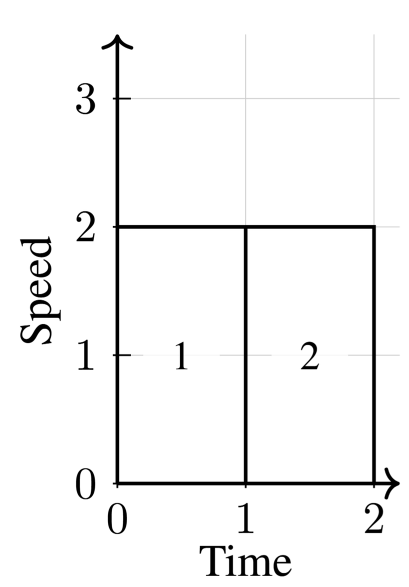
Objective

- Minimize the intensity of the schedule, e.g., minimizing

$$\int \left(\sum_j s_j(t) \right)^2 dt$$

Example

j	r_j	d_j	p_j
1	0	2	2
2	1	2	2



Electric Vehicle Scheduling

Instance

- Jobs j
- Arrival times r_j
- Departure times d_j
- Charging demand p_j
- Maximum charging rates ℓ_j

Decision variable:

- Schedules $s_j(t)$ specify at what power vehicle j is charged at time t

Feasible solution

- Vehicles only charge between arrival r_j and departure d_j
- Vehicles charge their entire demand p_j
- At no time does the charging power exceed a vehicle's maximum charging rate ℓ_j

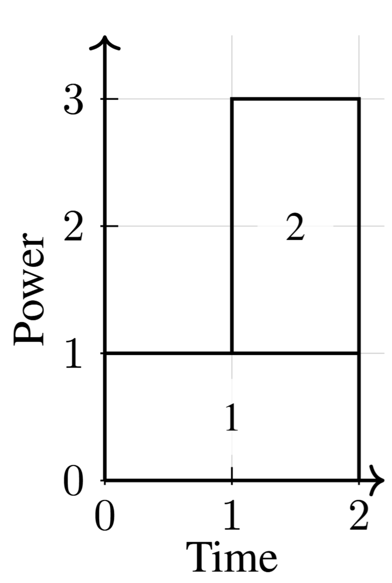
Objective

- Minimize the intensity of schedule, e.g., minimizing

$$\int \left(\sum_j s_j(t) \right)^2 dt$$

Example

j	r_j	d_j	p_j	ℓ_j
1	0	2	2	1
2	1	2	2	5



Least-majorized Flows

Instance

- Flow network N
- Target flow value τ
- (Majorization)
- Subset V_t of nodes adjacent to network sink v_t
- Positive weights d_v

Decision variable:

- Flow f on network N

Feasible solution

- f is a feasible flow on N
- f has flow value τ

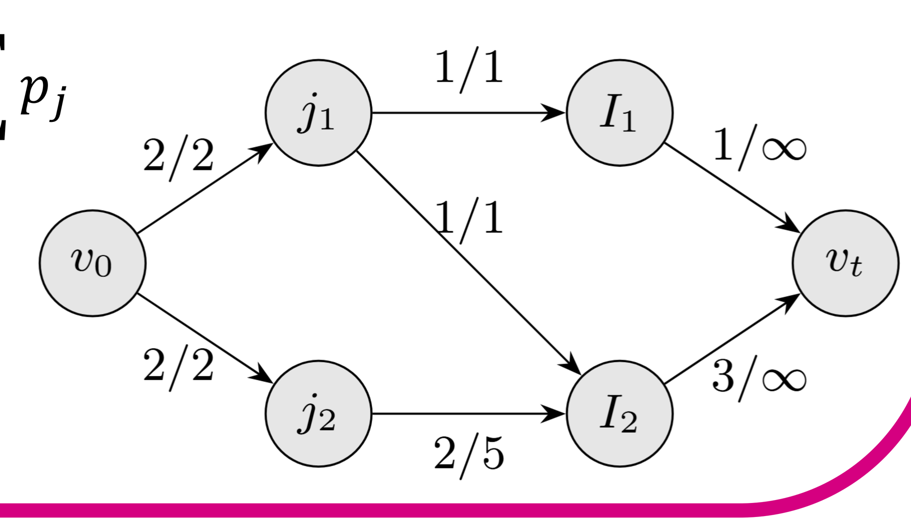
Objective

- Find a least-majorized flow f, e.g., minimizing

$$\sum_{v \in V_t} \frac{1}{d_v} f(v, v_t)^2$$

Example

$\tau = \sum_j p_j$



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