Network Stuff

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Abstract

None

1 Network Traffic Problem

In this section, we consider the problem of optimizing network traffic. A network is a graph $G = (V, E)$ with vertices $v_i \in V$ and edges $e_{ij} \in E = V \times V$. We would like to maximize the total traffic through a series of K paths across the network. A path is a sequence of edges $p^k_{st} = (e_{sv_1}, e_{v_1 v_2}, \dots, e_{v_m t})$ from source vertex s to target vertex t. A path contributes a constant amount of traffic x_p to each included edge $e \in p$. We denote the set of paths that pass through a particular edge by $\pi(e) = \{p \mid e \in p\}$. We additionally have the following constraints: traffic must be nonnegative $x_p \geq 0$, and each edge has a capacity constraint that the total traffic on that edge cannot exceed $\sum_{p \in \pi(e)} x_p \leq c_e$.

This yields the following optimization problem:

$$\begin{aligned} \text{maximize} \quad & \sum_p x_p \text{ or } \sum_e \sum_{p \in \pi(e)} x_p \\ \text{subject to} \sum_{p \in \pi(e)} & x_p \leq c_e, \forall e \\ & x_p \geq 0, \forall p. \end{aligned} \tag{1}$$

The first objective assigns equal weight to each path, while the second objective weights paths based on length.