Algebraic Formulation

Inputs

Distance Matrix, D (pre-calculated)

d_{ij} => distance between i^{th} incident (fire) and j^{th} fire station

Delay Factor Matrix, F

f_{ij} => delay based on current traffic conditions

$0 \leq f_{ij} \leq 1$

Effective Distance Matrix, E

$e_{ij} = d_{ij} + f_{ij} d_{ij} = (1 + f_{ij}) d_{ij}$

$d_{ij} \leq e_{ij} \leq 2d_{ij}$ (max effective distance = 2 x distance)

Availability Vector, A

a_j => number of trucks/crews available at station at time of call

updated in real time to track trucks out on calls

Decision Variables

Send fire truck matrix, S

$s_{ij} = \begin{cases} 1, & \text{if truck is sent from station } j \text{ to fire } i \\ 0, & \text{otherwise} \end{cases}$

Constraints

$\sum_j s_{ij} = 1$ => one truck is dispatched to every fire i

$\sum_i s_{ij} \leq a_j$ => total trucks dispatched from station j do not exceed total available

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Output

Minimize Total Effective Distance

$\sum_i \sum_j s_{ij} e_{ij}$