Facility Location

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Consider a company that sells only one product and has n warehousing facilities throughout a city. For simplicity, assume that a city is a unit square, $[0,1]^2$, where distances are measured in units of 30 km. Warehouses can be located anywhere within this region and are assumed to have an infinite supply of products, i.e. they will never run out of inventory. Orders arrive, from 8 AM to 5 PM, according to a stationary Poisson process with rate λ per minute and are located throughout the unit square according to density function $f(x,y) : (0 \leq x, y \leq 1)$.

Each warehouse has t_i trucks which deliver orders individually, i.e. they pick up one order, travel to the delivery point, deliver the products and return to their assigned warehouse to pick up the next order. Pick-up and delivery times are exponentially distributed with mean μ_p and μ_d, respectively. Whenever an order is received, it is satisfied from the closest warehouse with available trucks. If no such warehouse exists, the order is placed in a queue and satisfied, in FIFO order, as trucks become available. Orders must be satisfied on the same day in which they are received; even if trucks must work until after 5 PM to do so. All travel is done in Manhattan fashion, i.e. when traveling from (x_1, y_1) to (x_2, y_2), the truck first travels from (x_1, y_1) to (x_1, y_2) (vertically) and then from (x_1, y_2) to (x_2, y_2) (horizontally) and at a constant speed v km/hr. Idle trucks rest at their assigned warehouses.

The goal is to determine where each of the n warehouses should be located in order to maximize the proportion of orders for which delivery is completed within τ minutes of their arrival.

Recommended Parameter Settings: Take $v = 30$, $\tau = 60$, $\mu_p = 5$ and $\mu_d = 10$; f is proportional to $1.6 - (|x - 0.8| + |y - 0.8|)$. The arrival rate, λ may be chosen at will, with the number of warehouses and trucks chosen accordingly. The simulation implements $\lambda = \frac{1}{3}$, $n = 2$ and $t_1 = t_2 = 10$.

Starting Solutions: Locate both warehouses at the center of the square, i.e. (0.5,0.5). If multiple solutions are needed, select locations uniformly at random within the square.

Measurement of Time: Number of days simulated

Optimal Solution: Unknown