The problem is to identify the number of vehicles required to service a region where demand can be from anywhere in the region and the time between arrival of demand follows exponential distribution.

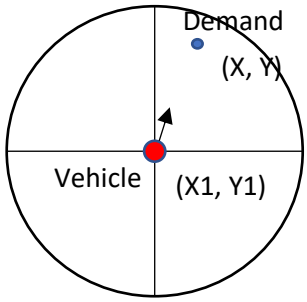
Assumptions:

1. Time to service is 15 min
2. Average speed of truck is 25 miles/hour.

Model:

To solve this problem, a vehicle routing approach can be modeled in ARENA. The model is as follows:

1. Mean Time between demands is determined in minutes. (365*24*60/D minutes), where D, Annual demand, is calculated based on population in each region.
2. Using an **Exponential Distribution**, demand instances are created with mean time calculated above.
3. Once, the demand is created, it is assigned some attributes X and Y as below,



$$X = R * uniform(0,1) * \cos(2\pi * uniform(0,1))$$

$$Y = R * uniform(0,1) * \sin(2\pi * uniform(0,1))$$

R – Service Distance (miles)

X, Y are random coordinates for demand points assigned using polar coordinates. They are assigned assuming the demands are equally distributed in the service radius. X1, Y1 are coordinate of the vehicle.

$$Time\ for\ veh1 = U(t) * (Reach\ Time\ for\ veh1 - TNOW + 15) + \frac{60}{25}\sqrt{(X - X1)^2 + (Y - Y1)^2}$$

$U(t) = Vehicle1\ Utilization\ at\ time\ t$

$Reach\ Time\ for\ veh1\ = Time\ taken\ for\ vehicle1\ to\ reach\ the\ last\ demand$

$TNOW\ = Time\ at\ present$

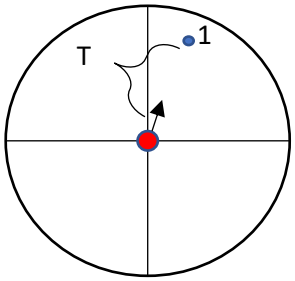
4. Considering time taken for truck1, if a demand point occurs when truck is stationary, then utilization U(t) = 0

$$Time\ for\ veh1 = \frac{60}{25}\sqrt{(X - X1)^2 + (Y - Y1)^2}$$

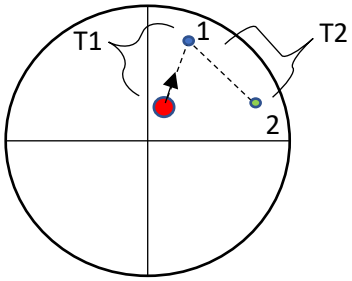
5. But, if a demand point occurs when vehicle is on the way to another demand point, then U(t) = 1

$$Time\ for\ veh1 = U(t) * (Reach\ Time\ for\ veh1 - TNOW + 15) + \frac{60}{25}\sqrt{(X - X1)^2 + (Y - Y1)^2}$$

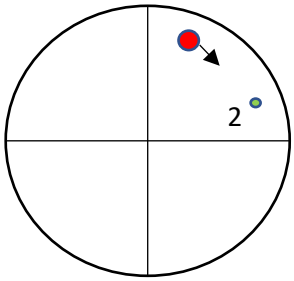
6. The above mentioned condition is explained as follows



Demand 1 occurs and time taken T to reach is within service time so vehicle leaves to serve order



When vehicle is on the way to serve demand 1, a new order 2 is placed nearby



If the time (T1+T2+15) min is less than service time, then the new order 2 is also covered by vehicle

7. The above model, is for 1 vehicle. In the case of multiple trucks we split the service region equally in quadrants for each vehicle and constraints can be added in the simulation model to divide each truck to corresponding quadrants