1. Identifying real world problem

In developing countries like ours have **finite number** of resources when it comes to services such as ambulance services.  
Current ambulance dispatch services have delayed dispatch times and it greatly affect the quality of the service due to the lack of resources. This could greatly affect in situations like cardiac arrests.

1. Current problem solution
2. Knowledge about the problem domain

Busy EMS 🡪 delayed dispatch times

Send one or more ambulances

contact ambulance

Check priority

Central emergency phone number

person

Solution: - decentralizing emergency phone call receiving

* Problem 2:

The proportion of emergency calls that can be responded within a predefined time threshold is very low due to lack of resources

Solution:

Goal : - minimize this time

How?

Allocating the finite number of ambulances efficiently.

Configure the number of ambulances and allocating a fleet of ambulances to given stations.

Required data

Travel times and paths

Location details

Demand for ambulance service in regions

How are we gonna get them?

By analyzing gps data of ambulances.

**Overall solution:**

**Develop an statistical mathematical model to predict the future locations of ambulances,**

* **By the time of the day**
* **By the day of the week**
* **By special occasions (like New year, Christmas)**

To develop a mathematical model for the optimal location of ambulance services based on current ambulance locations, a set of hospitals, and a set of demand locations, we can use a variant of the capacitated facility location problem. The objective is to determine the best locations for additional ambulance stations to minimize the total travel distance or time to serve the demand while considering the existing ambulances and hospitals.

Let's define the variables and parameters:

- Set of current ambulance locations: A = {a1, a2, ..., an}

- Set of hospitals: H = {h1, h2, ..., hm}

- Set of demand locations: D = {d1, d2, ..., dk}

- Binary decision variable indicating whether a new ambulance station is placed at location i: x\_i (1 if an ambulance station is placed at location i, 0 otherwise)

- Binary decision variable indicating whether demand location j is served by an ambulance station at location i: y\_ij (1 if demand location j is served by ambulance station i, 0 otherwise)

- Distance or travel time between each location: c\_ij

The objective function can be to minimize the total travel distance or time:

Minimize: Z = ∑(∑(c\_ij \* y\_ij))

subject to the following constraints:

1. Each demand location must be served by at least one ambulance station:

∑(y\_ij) ≥ 1, for all j ∈ D

2. Each demand location can only be served by one ambulance station:

∑(y\_ij) = 1, for all j ∈ D

3. Each ambulance station can serve a limited number of demand locations based on its capacity or coverage radius:

∑(y\_ij) ≤ C\_i, for all i ∈ A

4. Each hospital can serve a limited number of demand locations based on its capacity or services:

∑(y\_ij) ≤ D\_i, for all i ∈ H

5. If a demand location j is served by an ambulance station i, then the ambulance station i must be selected:

y\_ij ≤ x\_i, for all i ∈ A and j ∈ D

6. Additional constraints, such as budget restrictions or considering maximum response time, can be added as needed.

This model can be solved using mathematical programming techniques such as integer programming or heuristics like genetic algorithms or simulated annealing. The solution will provide the optimal locations for additional ambulance stations that minimize the total travel distance or time to serve the demand while considering the current ambulance locations and the set of hospitals.