EMS Redirection Simulation

4ZP6 Capstone Project

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Abstract
In this proposal we will present the current situation of ambulance wait times in Ontario. Then we will propose our idea to alleviate it. In order to show the relevance of our idea we will create a simulation of our solution. We will talk about the Monte Carlo simulation, then go through the methodology of our simulation to show how it will work. We will then present how the simulation interface will appear followed by the simulation outcome. Then we will present the assumption we will be making in our simulation. Lastly, we will show the scope to which our simulation will apply.

Author Keywords
Code Zero; simulation; Monte Carlo; wait time; EMS

Motivation
Code zero ambulance emergencies are extremely high in Hamilton. This is a situation where either just one ambulance is available, or possible none at all. Even worse, code zero is happening more frequently - in January 2018, there were 31 code zero events[1]. Our motivation for this project is the amount of code zero emergencies.

Goal
The goal of this project is to reduce wait times in Ontario's emergency rooms by redirecting non critical patients to other medical/treatment facilities. For instance, comparing wait times in emergency rooms after a certain percentage of overdosed patients are assigned to an detoxification center. Through extended simulations, we can find the optimal distribution of resources and conclude if it's possible to prevent Code Zero (zero ambulances are available for service) from occurring.

Simulation
A Monte Carlo simulation is a way of estimating the value of something through the use of statistics and repeated simulation. It has a population, which is the set of all possible examples, and a sample which is a subset of the population. We take a random sample of the population, and infer that it has the same properties as the population it is taken from. If we take many random samples, we can take a mean or average of the results and get a more accurate estimate.

The key part of a Monte Carlo simulation is the randomized aspect. The sample is taken randomly but within a sensible range. In our case, we might have every simulation have the same types of patients but randomize the severity of their injury. This means our population is the set of all possible severities, and the random sample is a certain severity for each patient.

Methodology
Tokens

- EMS(i,j) the crew that receives the patient
    - i - this is the id for the crew
    - j - this is the id for the patient
- Category(k,j) what category their injury is in
    - k - this is the id for the injury
- Accident - has attributes:
    - Timestamp (when EMS arrives)
    - Location (where accident took place)
    - (should also take i to note which EMS crew is arriving)
- EM(i) - the center that crew i will take its patients
    - Has attribute i for crew
    - Has attribute for the center
- EMS Availability(i) - has attributes
    - i - for the crew
    - How long till there available next

Input

- A list that has:
    - All EMS crews we are running the simulation on
    - Timestamps of availability
    - If they were not available what were they tasked with
    - All centers that will be involved in simulation(this will obviously have the Hospitals that the EMS crews adhere to but it should also have other centers that they would be diverted to)
- It will also take a table that has the percent chance for every type of condition that were testing for, if it is something which needs an emergency room or not

Step 1

- Take the given input and count total time that code zero took place

Step 2

- Start the simulation with given input list
- The simulation will run and redivert ambulances to other centers (EM) if they can be
    - This will be based on the chance that the given condition does not need to go to the emergency room
    - There will also be an algorithm that will take factors such as distance into account when redirecting ambulances
- This will create a list just like the input list but with new timestamps for availability since now ambulances will not have to wait at the hospital if they can go to other centers instead

Step 3

- Count total time that code zero took place in the simulation and generate report with the findings

Step 4

- Repeat steps 2 and 3 with a new table for percent chance that a given injury needs to go to the emergency room
- This will be done enough times to see on average how well will our system of diverting ambulances contribute to ambulance wait times

Interface

The user interface will be designed with the greatest emphasis on usability, and ease of use so that emergency responders will have the greatest likelihood of utilizing the application to its full potential. By observing how other applications have been implemented in disaster scenarios we will focus on the following key factors when designing:

- Our UX strategy must be comprehensive and account for adaptability to issues that may come into focus only after conducting user research.
- Key information must be accessible within a limited amount of taps/clicks.
- Focus on essential information and usability will be key in creating a successful crisis application.

The other interface that we will be designing is how our simulation will display and show results. The goal is to have a UI that will allow the user to play with the many different variables that could affect the outcome of a typical day for emergency services drivers. E.g. calls, locations of calls, density of calls, etc.

The UI for the simulation will allow its users to be able to determine how effective different algorithmic strategies are in minimizing resources, and reducing total code zeros. The UI will include a visual element as well, to further visualize the impact that the application will have on our target demographic.

Describe Outcome

The current situation is that not all cases that go to the emergency room require it [3]. If the emergency room is full the ambulances are supposed to wait outside till they can admit their patients. Our simulation will redirect ambulances to appropriate centers for its patients which will free up the ambulance from having to wait outside a hospital. This can have a domino effect which will allow more ambulances to be available to respond to calls which will help prevent a situation where there are no ambulances available. The outcome of our simulation will have more or equal ambulances available at any given time as opposed to the actual statistics at that time. This new ambulance timestamps will be output into a report which will

also have the amount of times code zero took place in our simulation as well as information about how the ambulances were redirected.

Questions(Unknowns)

All things considered, there are many unknowns that we will have to consider (or can't consider) for this project.

- ➔ Will our application be universally implemented (across Ontario) or will only some emergency services / hospitals adapt it.
- ➔ What would the impact be if we only help some emergency service drivers, and don't have access to others, how will this affect our simulations?
- ➔ What are the environmental and unknown factors that affect when our research is conducted / when it is implemented, will there be a significant difference?
- ➔ If we discover that in practice our application / algorithm is not what our simulations have predicted, how can we change / tweak it, after we've released it?
- ➔ How can we properly test our application for all scenarios we expect, as well as scenarios we don't expect.

Scope

The estimated time the project will take

Description	Estimated time of arrival
Advertisement poster	November 23, 2018
Collect Tweets	December 31, 2018
Onboarding Interview	January 31, 2019
Populate PERT chart	TBA
Final Report	End of May
Presentation and Demo	Early April

All the different pieces that need to be built (Ontario Hospitals wait time API, implementation and refining of the algorithm, writing the app, research, monte carlo, etc.)

- Data
    - Diagnosis and frequency of patients (eg, gun wounds, overdose, fractured bones)
    - Distance/time to each hospital. A node graph for visual representation (nodes would be the hospitals, edges would be the average time to each hospital)
    - Total number of available resources, ie, ambulances and ER
    - Average time patients spent in Emergency rooms
- Algorithm
    - Refer to Methodology
- Simulation
    - Initial simulation to demonstrate result matches the system as is (verify simulation is accurate)
    - Monte carlo simulation with a redistribution of patients, ie, percentage of overdose patients are redirect elsewhere.
    - Allows the user to tweak any of the redistributing settings
- App
    - Smartphone app that tells EMS drivers where to go based on the type of injury and available resources

- Final report
    - Conclude the finding. Is there an optimal distribution? Is possible to prevent Code Zero.

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