Evacuation Scenario

The Conceptual Model:

Our conceptual model focuses on the three most important factors in an evacuation scenario: the parking lots, roads, and traffic stops. We will assume that no cars enter the campus during the crisis and that the amount of time it takes for individuals to reach their cars is negligible compared to the overall amount of time needed to exit campus. We also assume that no pedestrians or accidents interfere with travel on the road. Thus, the simulation only depends on how quickly a certain number cars in the parking lots around campus can exit campus based on the road size and direction at traffic lights.

Each road will be considered as a first-in-first-out (FIFO) queue, with the capacity directly related to the length of the road. This length will be estimated through Google maps. Further, the speed of the cars, and thus the time in which cars remain in the queue, is inversely related to the number of cars in the queue. Thus, if only one car is driving down Hemphill, that car can go the speed limit of 30, but given a large amount of traffic, the car must go slower. The input to these queues is simply the parking lots, and exit is I-75. To simulate a real life scenario, a random number of cars both on the road and in the parking lot will be generated.

Accurately modeling the behavior at stop lights is slightly more nuanced. There are two possible situations: people are left to decide which direction they wish to go, or an officer is present to guide traffic. In the event of an emergency, these different scenarios can be broken down as follows. Considering a chemical storm of death is quickly descending on campus, one can assume every individual will greedily choose to go East. In the event that the road east is full, the individual will randomly choose another available road either North or South. When officers are present, they send traffic down the least crowded road every 20 seconds (the clock cycle).

A few more features are present to model the real life scenario. It will always be assumed that it takes a car a minimum of 10 seconds to enter and exit an intersection, regardless of the presence of traffic officials. Further, if the road is full ahead, then traffic comes to a stop on the road behind it. Also, cars entering roads from parking lots follow the same rules as cars traveling through intersections.

Software Architecture

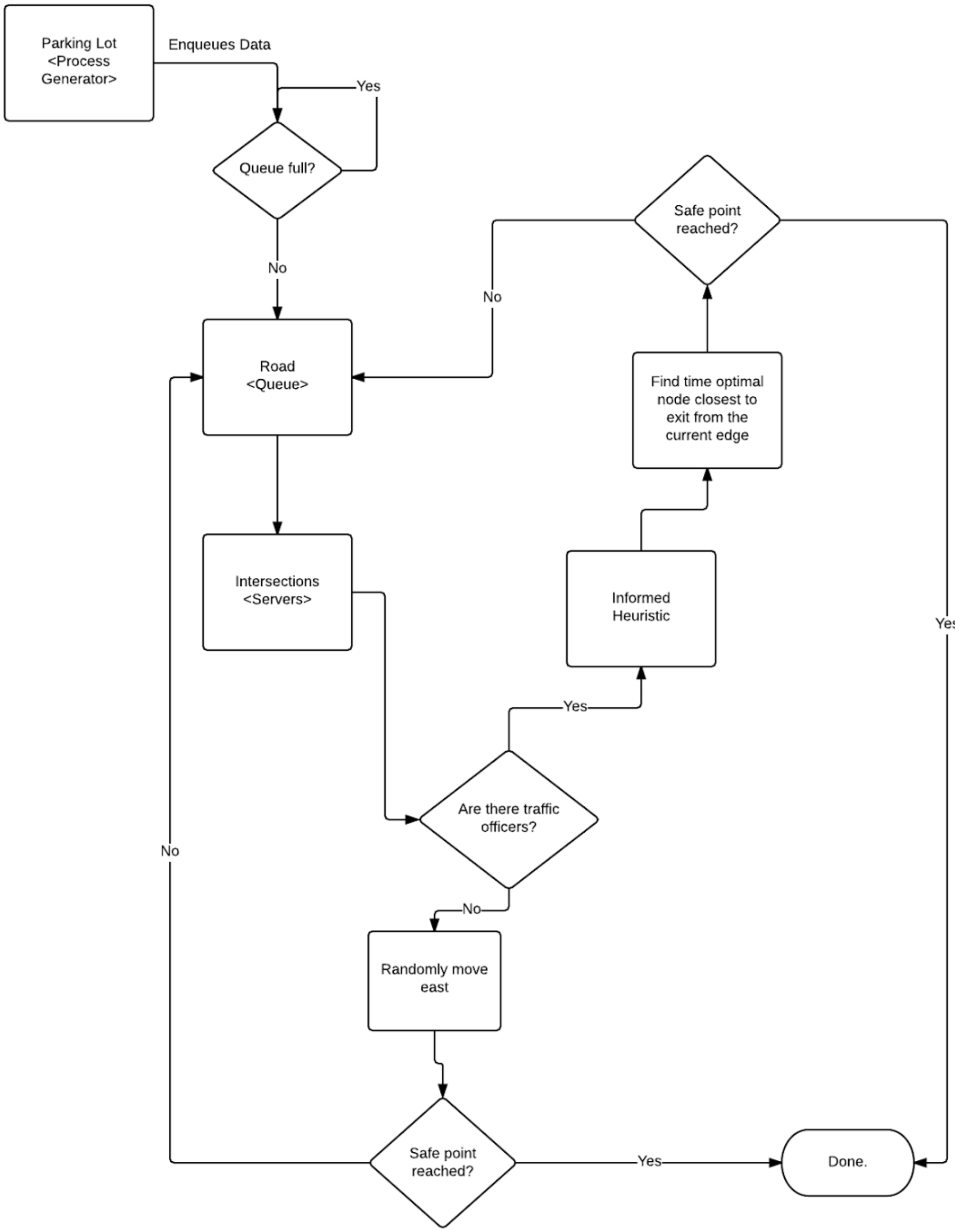
Regarding the overall software architecture, we chose to use the SimPy preexistent library to implement queuing for this project. SimPy encompasses several resources that can be effectively used to model a potential evacuation of the Georgia Tech campus. Among some of these, we plan to use the SimPy random generators and Resource objects to create several different distributions of vehicles across campus. This allows us to access potential different scenarios of evacuation. For example, we can create a normal distribution of cars across campus, to simulate a normal and peaceful day inside Georgia Tech and see how people would react when they are forced to evacuate because of the chemicals. On the other hand, we can use an exponential distribution to model an uneven distribution of cars in the parking lots, perhaps as a result of a concert at Tech Green, where almost all of the cars would be concentrated around the Clough surroundings. Notice that the latter situation implies that we have an equal population to the base case,as we are assuming the number of students and faculty remains constant.

More importantly, SimPy allows us to simulate using process oriented paradigms, where we can have one thread simulating cars arriving at a determined road and another thread representing cars being routed towards a different road. The latter thread is then able to wake the subsequent thread and thus be able to effectively simulate the movement of cars. This allows us to implement complex and interesting behaviors, as we can deliberately change the logic behind the traffic light thread. For example, we can simulate scenarios where traffic officers are present at each line controlling the flow in an optimal manner, since they have aerial and radio information on the entire system. We can compare this scenario to an apocalyptic one, where the admission test for traffic conductors ceased to exist and UGA grads were then able to get jobs as traffic officers and now these young professionals are responsible to direct the cars in the intersections. However, they do not know how to turn the radio on to receive outside information, which leads to them to optimize locally instead of globally. Also, if time allows, we intend to simulate this scenario as a max flow problem in a network and compare the results with the queueing model.

Regarding overall software architecture, we intend to use a Singleton Object that represents the entire GT campus, containing within itself pointers to the different Processes and Resources. This is an authentic representation of real life, as the traffic officers would have information about the entire system due to satellite imaging, Google Maps, officer feedback,etc. In addition, we will have classes for parking lots, intersections, and roads.As it was mentioned above, SimPy offers us the resources to effectively model these classes as according to our conceptual model. Each class will have supporting and helper methods to enable us to build an effective, precise and creative system.

We intend to use the Google maps API to get more information on the campus roads and capacity, correlating these metrics to the maximum queue size. It is also worth noticing that in a real life evacuation scenario, roads that have two-way flows tend to have both flows combined into a single evacuation lane, with the obvious purpose of enhancing evacuation speed and allowing more space for the cars to use. We intend to compare both models to see how effective this strategy is.

Flowchart for the system:


Parking Lot
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Enqueues Data
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Queue full?
No
Safe point
reached?
No
Road
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Find time optimal
node closest to
exit from the
current edge
Intersections
<Servers>
Informed
Heuristic
Yes
Yes
Are there traffic
officers?
No
No
Randomly move
east
Safe point
reached?
Yes
Done.