Our Work

For this question, after preliminary analysis, we believe that it is difficult to determine the proportion of medicine packages and drones without determining the locations of the cargo container, let alone associated packing configuration. Therefore, we start with identifying the best locations of cargo containers and then address the whole problem.

To select the best locations, we take transportation cost and reconnaissance capability into account. For the former, we establish a transportation cost function based on the distance and weight of transported goods. Given the constraint of this function, we can use the constraint boundary to find the extrema and then find the location with the lowest cost. For the latter, we consider that a position is a better choice if drone starts from this place can cover a larger area and more major highways. We use the maximum radius of potential candidate drones to estimate the reachable area. Finally, we can decide the best locations.

Once the locations are determined, we can calculate the quantity of each medicine package in each cargo container, and the type and number of drone can be determined. Then we use simulation software *EasyCargo* to load cargo container. All the drones and medicine packages are packed to minimize unused space. Finally, we get the packing configuration of each container.

Now we can get the drone fleet at every location. Next step is to develop delivery and scouting plan.

For delivery mission, our goal is to use as few drones as possible, which means we have to optimize the drone payload packing configurations. According to the distribution of the main roads and the flight distance limitation of the drones, we can determine the ratio of the drones performing one task and two tasks simultaneously and their routes. Besides, since the drone must land to be unloaded, we take into account the ground unloading capacity in order to prevent crowding and hovering, and establish the schedule for specific drone type.

For reconnaissance mission, our goal is to cover all the major roads as soon as possible. we first use the grid method to abstract the targeted highways, and then we use cellular automaton to simulate to get the optimal plan. Greedy algorithm is used to give primary transfer rules and weight functions. Afterwards, we apply sensitivity analysis of the parameters used in the model to verify the sensitivity and rationality of the parameters.

Finally, we analyze the advantages and disadvantages of the model, and then provide some simple and feasible tradeoffs in case of insufficient delivery or reconnaissance ability due to excessive demand for drugs.