Project Proposal
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Problem Domain
Hybrid algorithm for UAV routing and supply delivery.
The first NPC problem which will be considered is a variation of the VRP where we have some number of UAVs D, each with a uniform amount of fuel F, and some number of target locations which need to be observed T. The base from which they leave will be the "depot" in this case and will be a special element of T known as T_{Home}. The cost c of the edge $(t_i,\ t_j)$ will be the amount of fuel required to travel that distance. This is similar to what was done in [1] without the consideration of the complex urban environments. The constraints will be that each location must only be visited by one drone, since it is unnecessary to have multiple viewing the same location, and some locations will be marked as "high priority" and must be visited first. We will assume that the terrain is level and all drones fly at the same altitude. More formally, the problem can be stated as follows: Given a graph G = (T, C), where T is the set of targets and C is the set of edge costs in gallons of fuel, find a set $r = \{T_{Home} \cup t_i\ \forall i \in T | c < F \text{ and } c \text{ is minimized}\}$ for each drone in D. Additionally $\forall d_i \in D,\ r_i \cap r_j = \{T_{home}\} \forall i \neq j$.

The second NPC problem to be incorporated will be the 3D bin packing problem [2]. Assume that all locations require supply drops of varying size and each drone has a fixed 3 dimensional capacity L. We want to minimize the number of drones required to make supply drops. This problem on its own can be stated as follows [3]: Given a set of items I, a set of sizes S representing the size of each item and a bin capacity L find the minimum K such that $K = \sum_{j=1}^{n} y_j$ where $y_j = 1$ if drone d_j is used to carry supplies.
The combined objective function can be formulated as follows:
$H = [cost(t_i, t_j)\ \forall i \in r_x\ \forall x \in D] + \sum_{j=1}^{n} y_j$. Our goal is to minimize this hybrid objective function. In other words find the routes that use the least amount of fuel while simultaneously finding the least number of drones required to make all supply drops.

References
[1]Semsch, E., Jakob, M., Pavlicek, D., & Pechoucek, M. (2009, September). Autonomous UAV surveillance in complex urban environments. In *2009 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology* (Vol. 2, pp. 82-85). IEEE.

[2]Martello, S., Pisinger, D., & Vigo, D. (2000). The three-dimensional bin packing problem. *Operations research*, *48*(2), 256-267.
[3]https://en.wikipedia.org/wiki/Bin_packing_problem#Formal_statement