BRAIN STORMING REPORT

1. Describe the Performance and Environment for the sUAS planning problem.
   - P: Generate as many performance metrics as you can think of, then select two that are most promising.
   - E: describe the domain in terms of environmental dimensions: Observable, Deterministic, Episodic, Static, Discrete,Single-agent? and give your justification in two to three complete sentences
2. Is this problem, a planning or a scheduling problem, or both?
   - Define a planning problem and define a scheduling problem.
   - Justify your answer using those definitions
3. Represent the problem file in PDDL
4. Is there any hierarchy to take advantage of? Why or why not? Why wouldn't GRAPHPLAN work?
5. Would MINCONFLICT work? What would be an attribute(s) to minimize?
6. Would a contract net protocol (bidding) work?
7. What is a "critic" and how might it be useful for this problem?
8. What is "relaxation" and how might it be useful for this problem?

Ans 1.

P : Performance Metrics

1. The allotment of distance based on the battery capacity of the UAVs. The UAVs with smaller battery capacity is allotted small distances which means that the agent has to take into consideration the battery capacity of all the 14 types of sUAS while evaluating the performance.
2. The capability of all the pilots do differ which means that all the pilots would not be eligible to fly all the different types of UAVs. Some pilots may be highly skilled while some pilots may be semi-skilled so it is very important to take into consideration the capability of pilots while calculating the performance of the system.
3. The expected flight time of the UAV must be less than the maximum flight time of the UAV (maximum distance that can be covered by a UAV).
4. As we know, there are 7 types of missions in the problem so we must take into consideration the type of mission we consider in the problem so that the control style of the mission does match.
5. As mentioned in the design statement, each team needs to be given enough missions so that each team gets 8 hours in the field. This must be done optimally so that no team gets way less than 8 hours and no team gets much more than 8 hours.

E: Environmental Dimensions

1. **Fully/partially observable**

The system is both fully and partially observable. The system is fully observable in the morning and as time proceeds, the system becomes partially observable as new missions are added unpredictably throughout the day.

2. **Deterministic/Stochastic**
   The system is deterministic in the morning. It means that during the morning hours, the system has a set of mission and location requests so we define our set of actions beforehand in a planned manner but as time progresses, a lot of new ones are added unpredictably thereby making it a stochastic system.

3. **Sequential**
   When we assign a pilot to a particular mission, we do not assign another team to the same mission if it is successful. It is only when one team fails that we go on to assign another team for the same mission so this makes our system sequential.

4. **Static/Dynamic**
   When we talk of the environment, we know the locations where we need to search beforehand. This makes our environment static as all the conditions about the environment have been defined before hand in the problem statement.
   But as the problem statement states that there is an element of uncertainty associated with it, so it is very much possible that the system becomes dynamic.

5. **Discrete**
   The environment in our problem as finite and distinct states which is already pre-defined in the description of the environment which has been assigned to us in the problem statement.

6. **Single agent**
   Here, only one agent does all the planning for the entire mission which makes the system a single-agent system.

Ans 2.

A planning problem generally consists of 3 parts:

- Initial state
- Goal state
- Operators

A scheduling problem too consists of 3 parts:

- A set of actions
- A set of resources
- A set of constraints

So, now let us define our problem in terms of scheduling:

The set of actions would consist of 2 parts:

1. Assigning models to missions which means that the UAVs would be classified as per their battery capacity to a particular type of mission. The one with the lowest battery capacity would be given the nearest mission and vice-versa.

2. Assigning pilots to models depending on the capability of the pilots which mean that the pilot with the highest skill set would be given a UAV to fly a longer distance compared to a less skilled pilot who would be given a UAV to fly a shorter distance.

Here, the set of resources refers to the 14 models of UAVs which have been defined in the problem statement assigned to us. There may be many UAVs belonging to a particular model which would be used for rescue operation at Harvey.

Lastly, the set of constraints means that all the pilots are not qualified to fly all the 14 UAV models so this sets up a constraint which we need to follow and thus, need to assign the models to the pilots accordingly.

Now, defining the problem in terms of planning, we can consider 3 parts:

1.Initial state: The initial state in this problem can be defined as the 7 different mission types, the locations where search needs to be conducted and the UAVs which need to be assigned for a particular mission depending on the battery capacity of the UAV.

2.Goal state: The goal state in this problem can be defined as fulfilling all the mission and location requests at the end of the day. New requests may pop up instantaneously at any part of the day and fulfilling them taking all performance metrics into consideration is the last goal state.

3.Operators: In our case, scheduling forms the operator part of the system.

Ans 3.

PDDL Problem:

Init(SetofMissions ^ At(UAV,StartLocation) ^ At(SetofPilots,StartLocation))

Goal (MissionSuccessful ^ At(UAV,StartLocation) ^ At(SetofPilots,StartLocation))

Action(Assign(UAV, CapabilityofPilot))

Precondition(Have(differenttypesofUAV) ^ !Assign(UAV,Mission))

Effect(!Have(differenttypesofUAV)^Assign(UAV,Mission))

Action(Assign(UAV, Pilotaccordingtotheircapability))

Precondition(Have(differenttypesofUAV) ^ !Complete(Mission))

Effect(!Have(differenttypesofUAV)^Complete(Mission))

Action(Assign(UAV,Batterylife))

Precondition(!Complete(Mission) ^ Assign(Pilots,UAV))

Effect (Complete(Mission))

Action(Fly(UAV))

Ans 4.

According to me, for this problem, there is no hierarchy to take advantage of. This is because we cannot allocate resources independently. To support my statement, I am stating a few instances below where hierarchy would certainly fail.

All the pilots cannot fly all the UAVs.

Only a certain number of UAVs can be used to fly long distances i.e. only those UAVs which have a larger battery life.

Most importantly, a request can pop up anytime and it would completely depend on the availability of resources which are with us at that moment that we would consider while making any decision as to which we would have to send the UAV/pilot to a particular location.

GraphPlan can be defined as sitting in here somewhere in the middle. It iteratively commits to a particular depth and then searches for a plan within that depth. It circumscribes the set of tasks, or the set of steps that it's going to try to fit together into a plan. So it tries to say, all right, I'm just going to look in the space of two-step plans, that limits my options in some sense, and I can do that somewhat more efficiently. Every task requires a pre-condition and an effect attached to it.

Since, in our case, there is no particular hierarchy of events so GRAPHPLAN would not work in our case.

Ans 5.

Yes, MINCONFLICT would definitely work since it is a scheduling algorithm. Here, we look to minimize conflicts taking two things into consideration.

(a). Firstly, we need to allocate the UAVs to the pilots according to their skillset which means that a less trained pilot must be given first preference compared to the pilots with a high skillset.

(b). Secondly, we need to figure out which UAV goes on the mission when both the UAVs have the same battery life. We need to formulate a particular scheduling algorithm for these UAVs.

Ans 6.

A Contract Net Protocol (bidding) is applicable only when there are multiple agents in the frame. In our system, there is only a single agent which performs all the actions right from planning to scheduling the actions in our case. Therefore, it is not applicable.

Ans 7.

When the case of conflict arises between shared resources, we use the concept of critic by assigning + or – to the resources. The ones with + are given higher priority and the ones with – are given lower priority.

Here, the concept of critic can be applied in two places:

Instance 1:

Conflict: When the number of pilots is greater than the number of UAVs

Critic: We need to give first preference to pilots which are the least skilled. Then, preference is given to the pilots who are highly skilled as they can fly more or less all the UAVs compared to the rest.

Instance 2:

Conflict: Out of the 14 different types of UAVs, a conflict may arise when we visit a place which comes in the range of more than 1 UAVs.

Critic: Here, we need to assign the UAVs which have shorter battery life to shorter distances and then the ones with longer battery life are used to travel longer distances thereby reducing the conflict.

Ans 8.

Relaxing the constraints for a problem is referred to as “relaxation”. In our case, the two parameters where relaxation can be applied are as follows:

(a). There are 14 different types of UAVs for the 7 types of missions but it is not mandatory to use all the UAVs in our mission so this means that this constraint can be relaxed.

(b). There are 7 types of missions and for each mission, the requirement of UAV may differ based on the distance so we need to allocate the UAVs based on their battery capacity but it may be relaxed if we do not have sufficient UAVs of a particular type to cover our mission.