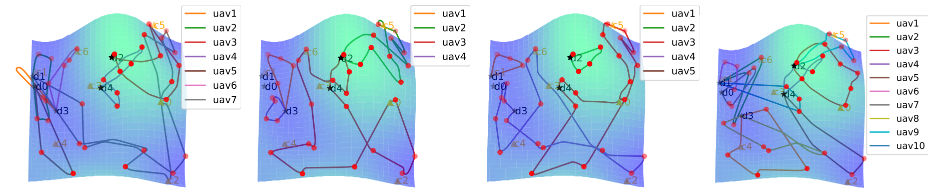
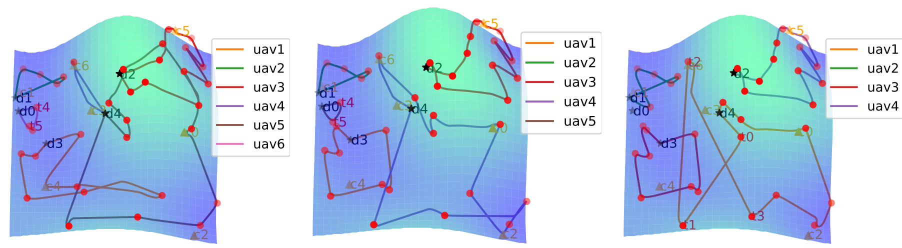
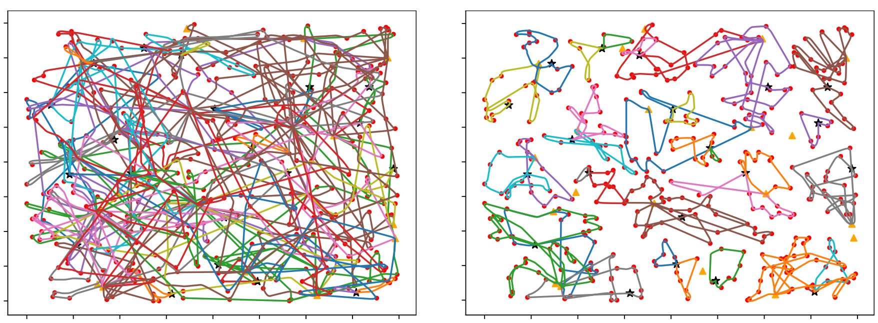


(a) GA: cost = 7097.48 (b) TS: cost = 5153.93 (c) GA-TS: cost = 4619.64 (d) SA-VND: 7496.83



(e) G-GA: 5475.45 (f) GGATS: cost = 4620.83 (g) FGATS: cost = 4512.13

Figure 1: The solutions obtained by compared algorithms for S3.



(a) GA-TS (b) FGATS

Figure 2: The 2-D flight paths of the GA-TS and the FGATS to illustrate the usefulness of the grouping strategy.

In Fig. 1, we present the best solutions obtained by FGATS and part of other algorithms over 30 runs for S3. **The full presentation and analysis can be found online.** This scenario contains 35 tasks and total 10 UAVs. As shown in Fig. 1, to complete all tasks as highlighted in red dots, each solution is composed of several flights (as marked in colorful lines) with 5 depots (as marked in black stars) and 6 charging stations (as marked in orange triangles). Each UAV must start and end at its depot.

Generally, there are no collisions during all flights, but the flights found by other algorithms look very chaotic and often require more cost to complete all tasks. As shown in Fig. 1 (a), GA falls into a local optimum, forcing a UAV to complete tasks that are far from its depot and making the cost higher. In Fig. 1 (b), the solution optimized by TS method is better than that optimized by pure GA. But the optimization ability is also bad. When combines TS with GA, as shown in 1 (c), GA-TS performs better in this small-scale scenario. However, an appropriate grouping strategy will further improve its optimization ability (as shown in 1 (g)). In Fig. 1 (d), SA-VND has utilized all UAVs to complete the tasks. After careful observation, we can see that the path of each UAV has been well optimized, but the UAV-based dividing method is clearly not suitable for multi-depot problem that takes distance and cost as objectives. High utilization of UAVs may result in short execution time, but it does not have a determined relationship with the flying distance or cost. In Fig 1 (e), G-GA also stuck in a local optimum in S3, because the fixed grouping strategy of G-GA affects the quality of the solution. We specifically compared the UAV path of GGATS and FGATS to illustrate the effectiveness of fuzzy grouping strategy. In Fig. 1 (f), it is necessary to dispatch an additional UAV to complete tasks t_4 and t_5 because they are assigned to d_0 by the greedy grouping strategy. However, in the fuzzy grouping strategy, t_4 and t_5 are completed by UAV of d_1 and d_3 respectively, making the cost of fuzzy grouping less expensive. In addition, in fig. 1 (g), the reason why UAV-1 completes t_2 first instead of going to the nearest task t_1 is that it can go to c_6 to charge after finishing t_2, then proceed to finish the other tasks (t_1 and t_0) and return to d_4. Otherwise, the mission assigned to UAV 1 will be unsuccessful since the remaining flight distance prevents it from finishing tasks and from reaching any charging station.

The benefits of the grouping strategies are not obvious given the relatively small scale of S3. To further illustrate the effectiveness of the grouping strategy, we also display the 2-D flight paths of the GA-TS and the FGATS in Fig. 2 for scenario S10. As shown in Fig. 2 (a), the path optimized by GA-TS is very chaotic. On the contrary, the solution found by FGATS in Fig. 2 (b) is much clearer.