



Research article

A fuzzy auction genetic algorithm for the vehicle-UAV collaborative delivery problem

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Appendix A: Fixed benchmark specification

The complete fixed benchmark specification is provided in this appendix. The fixed benchmark contains 15 tasks and three depots generated from base seed 42. No separate service-time variable is used in the model; service feasibility is evaluated through time windows, travel time, arrival time, and repair feasibility.

Table 1. Fixed 15-task benchmark input attributes.

Task	Lon.	Lat.	Type	Weight	Window	Pri.	Price	UAV	Pref.
T001	104.095593	30.879142	bulk transport	12.388592	76–417	2	96.450917	No	vehicle
T002	104.509088	30.714133	urgent delivery	15.957061	18–437	1	75.294235	No	vehicle
T003	103.843088	30.398376	bulk transport	9.064798	40–412	3	85.176996	No	vehicle
T004	104.175073	30.652778	sensitive transport	8.293166	169–326	1	63.223296	No	vehicle
T005	104.248844	30.787387	sensitive transport	7.316926	87–352	3	81.711898	No	vehicle
T006	104.108276	30.380317	remote delivery	5.558788	162–408	2	52.204338	No	vehicle
T007	103.968400	30.513900	precision delivery	2.633160	141–480	2	78.045343	Yes	UAV
T008	103.826099	30.807524	precision delivery	11.407605	37–410	1	52.091443	No	vehicle
T009	103.956452	30.571277	urgent delivery	7.744827	26–390	3	94.206735	No	vehicle
T010	103.957400	30.502600	sensitive transport	3.070236	41–345	2	51.239318	Yes	UAV
T011	104.117141	30.697800	bulk transport	12.368978	188–363	2	57.959892	No	vehicle
T012	103.970800	30.509800	remote delivery	3.808173	117–389	2	91.026819	Yes	UAV
T013	104.122807	30.787039	precision delivery	8.610881	17–497	2	67.557306	No	vehicle
T014	103.903389	30.683969	sensitive transport	14.647423	66–345	3	98.126716	No	vehicle
T015	104.517280	30.501954	urgent delivery	13.650710	111–455	3	55.782289	No	

Table 2. Capability requirements for the fixed 15-task benchmark.

Task	Capability requirements
T001	capacity = 0.847737, endurance = 0.779157
T002	speed = 0.891657, reliability = 0.799691
T003	capacity = 0.976173, endurance = 0.875854
T004	stealth = 0.801565, reliability = 0.963421
T005	stealth = 0.831090, reliability = 0.856351
T006	range = 0.850224, endurance = 0.881632
T007	precision = 0.927423, agility = 0.752391
T008	precision = 0.909118, agility = 0.866919
T009	speed = 0.979785, reliability = 0.642015
T010	stealth = 0.949896, reliability = 0.985153
T011	capacity = 0.956477, endurance = 0.782343
T012	range = 0.974433, endurance = 0.871719
T013	precision = 0.804733, agility = 0.738626
T014	stealth = 0.866230, reliability = 0.805520
T015	speed = 0.919314, reliability = 0.669137

Table 3. Depot coordinates for the fixed benchmark.

Depot	Longitude	Latitude
D01	103.964354	30.557743
D02	104.191195	30.540741
D03	103.961385	30.509090



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