User Guide for Integrating Activity Based Model (ABM) and Dynamic Traffic Assignment (DTA)

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1. Problem statement and data flow process

Given an agent file in a transportation network, DTALite simulates the route decision and produces the network-wide and link-level performances, as well as output agent results. An activity based model (ABM) can read the traffic performance data to further generate an updated agent file for another iteration of traffic simulation. Here are 12 main files involved within the ABM+DTA integration process. Table 1 provide a more detailed description of the files' functions and explanation of data content.

Table 1. Three Types of Data Block in Day-by-day Model Integration

Data Block		**File Name**	**Source of Data**	**Major Attributes**
A: Basic Input Files		A1: input_node.csv	Prepared from static transportation planning packages, GIS data sets	Node id, geometry
		A2: input_link.csv		Link capacity, length, speed limit
		A3.1: input_activity_location.csv		Zone id, external OD flag
		A3.2: input_zone.csv		Production, attraction
		A4.1: input_demand_type.csv		Demand types, information types
		A4.2: input_demand_file_list.csv		Loading multiplier, proportion of demand
		A5: input_scenario_settings.csv		Traffic assignment methods, traffic flow models
Day-by-day Integration	B: Input file	B1: input_agent.csv	ABM provide input to DTA	Departure time, path node sequence, information types, demand types
	C: Output files	C1: output_agent.csv	DTA's simulation output	Path node sequence, OD, trip time, distance
		C2: output_ODTDMOE.csv		Travel time, distance, toll cost, path node sequence for different demand type
		C3: output_summary.csv		DTA version, simulation setting process, simulation results

Step 0: Use NeXTA to prepare the basic network and demand data definitional data files from A1 to A5

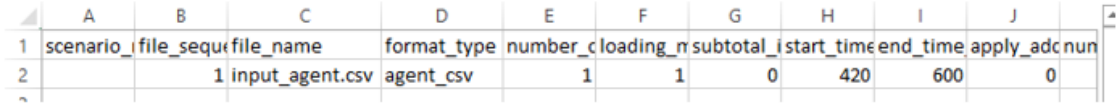
Step 1: ABM prepares input agent file B1 as a starting point: Input agent file B1 stores agents' essential travel information (origin, destination and departure time, demand type and vehicle type). Go to Step 1:

Step 2: DTA assignment/simulation: DTA here finds the least cost routes for individual agents and further simulates the interactions of agents to generate network-wide and link-level traffic performance. DTALite generates output agent file C1 with detailed trip trajectories and experienced travel time along selected travel path sequence. For running DTA for multiple days, users could access file A5 scenario setting to specific the day-to-day iterative runs, DTA will run toward user equilibrium for K iterations or days using Methods of Successive Average (MSA). Go to Step 3.

Step 3: Iteratively updating agent input from ABM to DTA

The output files in Data Block C (including zone-to-zone travel cost skim data C2) are feedback files for ABM to generate updated trip rates, destination and departure times for the agents for the next integration iteration. Go back to Step 2 to run another round of DTA simulation to update network wide traffic conditions.

2. Input settings and agent files from ABM to DTA



	A	B	C	D	E	F	G	H	I	J	
1	scenario_i	file_sequ	file_name	format_type	number_c	loading_m	subtotal_i	start_time	end_time	apply_adc	nun
2		1	input_agent.csv	agent_csv	1	1	0	420	600	0	

Fig. 1. Sample of input_demand_file_list.csv setting file

ABM would define input agent files in input_demand_file_list.csv (shown in Fig. 1), and provide detailed rosters of tours and trips in input_agent.csv for DTA to absorb and complete the simulation in the transportation network. Table 2 is the description of formats and attributes of input agent file.

Table 2. Fields in file input_agent.csv

Attribute	**Description**	**Sample Value**
Agent_id	Identification of the agent to be described on the network.	4
Tour_id	Identification number of each tour.	1
From _origin_node_id	Node identification of the agent trip start from.	2
To_destination_node_id	Node identification of the agent trip end with. Combined with origin node id to define trip which agent would go through.	17
From_zone_id	Agent in the same row travel start from specific zone with certain identification.	2
To_zone_id	Agent in the same row travel end to specific zone with certain identification.	17
Value_of_time	This attribute convert the value of travel time into the value of certain amount of money. Such as, 10 = $10 per hour.	10
Departure_time_in_min	Simulation clock time to describe agent departure from the origin. Unit: min	840.2
Demand_type/vehicle type/information_type/vehicle-age*	Those four attributes correspond to demand type, information type percentage and vehicle type percentage in file "input_demand_type.csv".	1
Path_node_sequence	The sequence of node id to represent the tagged agents' trip, and calculated by models. It definitely match the from origin id and to destination id, and current link id	2;6;8;16;17
PCE	….	
Trip_dependency		

As the table guides, all the information are about agents' trips. For example, certain agent has certain identification, departure in certain time from marked origin to marked destination, and they could have 4 types of demand, 3 types of information resources, then have been assigned certain path sequence by ABM. Besides, user cost for agents travel path are available to be calculated through the value of time. The figure below is the sample of input_agent.csv file.

agent_id	tour_id	from_zone_id	to_zone_id	departure_time_in_min	demand_type	PCE	information_type	vehicle_age	path_node_sequence
0	-1	1	2	420.6	1	1	4	10	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
1	-1	1	2	421.19	1	1	4	15	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
2	-1	1	2	421.79	1	1	4	5	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
3	-1	1	2	422.39	1	1	4	5	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
4	-1	1	2	422.99	1	1	4	10	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
5	-1	1	2	423.58	1	1	4	10	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
6	-1	1	2	424.18	1	1	4	10	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
7	-1	1	2	424.78	1	1	4	5	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
8	-1	1	2	425.37	1	1	4	10	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
9	-1	1	2	425.97	1	1	4	5	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;
10	-1	1	2	426.57	1	1	4	5	1;14;15;16;17;18;19;20;21;22;23;24;25;26;27;28;29;2;

Table 3 Activity Based Model (ABM) Tour Based Implementation

Trip name	Trip purpose	Origin Zone	Destination Zone	Duration	Dependency
Trip 1	Activity 1	From Origin	To Zone Z1	Example (1 hour)	None
Trip 2	Activity 2	From Zone Z1	To Zone Z2	Example (20 mins)	Trip 1
Trip 3	Activity 3	From Zone Z2	To Destination	Example (45 mins)	Trip 2

Any agent could start his/her tour at any departure time, and then arrive at first activity zone to complete the scheduled activities. Trip two would start depend on trip one completion, the departure time for trip two would be the sum of activity one's duration time and travel time, and all the cost time should accumulate with the simulation clock when trip one starts.

Through this flexible input agent file, for each agent, we can modify its following attributes.

A: changing total trip generation

B: changing departure time

C: changing destination

D: changing route

E: changing information type

3. Simulation results and agent file from DTA to ABM

Detailed simulation output description are illustrated from Tables 3 to 5.
In this simulation, 51 agents are initialized with one path, and Fig. 2 shows some important simulation results, such as, average travel time 32.7235 min, average speed 31.1702 mph.

	A	B	C	D	E	F	G	H	I	J	K
100	Output fil	RT_Output_ODMOE_10h00m00s.csv									
101	Iteration #	CPU Runn	Per Iterati	# of agent	Avg Trave	Avg Trip Time (min)		Avg Waiti	Avg Trip T	Avg Distar	Avg Speed (mph)	% co
102	1	0:00:04	0:00:04	51	32.7235	32.201		-0.52255	1.89418	17	31.1702	
103												

Fig. 2. Sample of output_summary.csv file with 51 agents.

Table 3. Output_Agent.csv (shaped lines are results of simulation output)

Attribute	Description	Sample value
Agent_id	Identification of each agent, summarized from 0 to 5413.	101
Tour_id/Origin_node_id/Destination_node_id/From_zone_id/To_zone_id/Departure_time/Demand_type/Vehicle_type/Information_type/Value_of_time	Obtained from input_agent.csv based on agent_id	
Complete_flag	Indicate whether the agents have completed their trips. Value c= complete.	c
Trip_time	The time usage of the trip.	15.07
Toll_cost	Toll cost. Unit: dollar	5
Distance	Total distance. Unit: mile	15
Number_of_node	Total number of the trip covered node	4
Path_node_sequence	Node id sequence to make up the trip	15;14;11;4
Path_time_sequence	Corresponding to the node id sequence, the sequence of time when agent travel arriving at certain node.	840;845;849;855
Link_travel_time_sequence	Travel time sequence represent the travel time on each passed link.	5;4;6

Table 4. Output_ODTDMOE.csv

Attribute	Description	Sample value
From_zone_id	Zone identification of agents' trip starts from.	1
To_zone_id	Zone identification of agents' trip ends with.	2
Departure_time	Same trip route may have different departure time.	840
DT1_TT	Travel time of demand type 1. Unit: min	7
DT2_TT	Travel time of demand type 2. Unit: min	7
DT1_Distance	Travel distance of demand type 1. Unit: mile	6
DT2_Distance	Travel distance of demand type 2. Unit: mile	6
DT1_Toll_Cost	Toll cost of demand type 1. Unit: dollar	4
DT2_Toll_Cost	Toll cost of demand type 2. Unit: dollar	5

This skim file is the main feedback mechanism from DTA to ABM, in which zone-to-zone travel times are informed by the traffic simulation model. Travel time, distance, toll cost, and path node sequence are summarized according to different demand type. The output summary records every detail for the whole process simulation. Simulation operators can recognize the DTA version, simulation setting process, and simulation results. It is the general output with detailed information. The difference between this file with the other two mentioned above is that the previous two output files are generated from a specific perspective, which is the agent perspective.

Table 5. Output_Routing_Policy_minXX.csv

Attribute	**Description**	**Sample value**
From_zone_id	Zone identification of agents' trip start from.	1
To_zone_id	Zone identification of agents' trip end with.	3
Demand_type*	This attribute corresponds to file "input_demand_type.csv".	1
Departure_start_time	Departure time window starts from, used for filtering agents who travel in a certain departure time window.	855
Departure_end_time	Departure time window closes at, corresponds with departure start time.	870
Path_no		1
Ratio_no		1
Node_sequence	Node id sequence to make up the trip	1;3
Node_sum_reference	Reference to identify the certain route combined with distance reference and travel time reference. The value equals to sum of the node id.	4
Distance_reference	Reference to identify the certain route combined with node sum reference and distance reference. The value equals to sum of the link length.	4
Travel_time_reference	Reference to identify the certain route combined with node sum reference and distance reference. The value equals to the total time length of travel time.	4.01
Number_of_agents	Number of agents who satisfy the three reference numbers in the same row.	2

This routing policy output file can be generate depend on time periods. The major function is tracking agents on the network. For achieving that function, three reference (distance, travel time, and node sum) have been in produced to distinguish and filter different agents. ABM would receive all the output files from data hub, analyze agents travel patterns, and then, modify input files for certain attributes for another day-by-day simulation.

Exercise 1: Prepare two agent files (51 agents and 101 agents) to test the impact of traffic demand on traffic simulation results (Goal: testing the impact of traffic network with trips increment).

Exercise 2: Prepare two agent files (51 agents and 21 agents) to test the impact of traffic demand on traffic simulation results (Goal: testing the impact of traffic network with trips reduction).