NEXTA Data Structure for Rail Scheduling, Version 1.0

Prepared for INFORMS 2012 RAS Problem Solving Competition

Movement Planner Algorithm Design for Dispatching on Multi-Track Territories

http://www.informs.org/Community/RAS/Problem-Solving-Competition/2012-RAS-Problem-Solving-Competition

RAS Toy Network Data Set is prepared by 2012 RAS Problem Solving Competition Organizing Committee

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If you have any questions about the competition problem, submit your question to RASProblemSolvingCompetition@gmail.com.

Please feel free to send any questions, feedback, and corrections to Jeffrey Taylor (jeffrey.taylor.d@gmail.com) or Dr. Xuesong Zhou (zhou@eng.utah.edu) by adding comments in this document and including the file as an attachment.

Table of Contents

NEXTA Data Structure

This document describes all input files associated with NEXTA for visualizing rail scheduling output. Each input/output file includes descriptions for all variable names, followed by a short description of their type, purpose, function, interaction with other variables, and the use cases in which the variable is required/not required.

Simple Step-by-Step User Guide

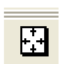
) Download the zipped file GUI_release_For_RAS.zip from the Google code site: http://code.google.com/p/nexta/downloads/list

2) Unzip the file to a folder on a Windows machine.

3) Go to subfolder “RAS_Toy_problem”, which has a reformatted input data set. The file output_schedule.xml follows the exactly same format as specified in the sample data set.

4) Go back to the installation folder, click NEXTA.exe

5) File->Open Rail Network Project, Open a train schedule *.xml in the subfolder RAS_Toy_problem.

6) Use mouse wheeler to zoom in and zoom out, and move network. If the network does not appear initially, click on button  in the tool bar to display the network and train/string diagram.

7) Click on tool bar 

to show timestamps of train entries, by min and by second.

8) Train trajectories are shown in solid lines when they are running on main tracks, otherwise as dotted lines on switches and sidings.

9) Go to menu tools->Train List, select a train to highlight its corresponding path on the network and schedule on train/string diagram.

10) Go to menu tools-> Check Schedule Feasibility to check the feasibility of train schedule. Currently, only headway, nonconcurrency and MOW constraints are checked.

11) Similar to using a GIS package, you can select link layer, and click on “” in the tool bar and use mouse to select a link in order to show the corresponding attributes.

Input Files

The following tables describe the input files used in NEXTA for rail scheduling. Most tables can be defined as either essential input data (indicated by **Essential input data** label) or nonessential input data, while individual variables (columns) in each table may also be considered as optional variables.

1. Network Files

Network input files define the basic node-link structure used in DTALite and NEXTA, along with attributes for each link and node. Additionally, nodes are related to zones and activity locations, which can be used to disaggregate trips from zones to nodes and activity locations.

input_rail_node.csv [Essential input data]

The input_rail_node table defines the nodes in the network in terms of names, ID numbers, location/position, and characteristics.

Variable Name	**Type**	**Optional**	**Acceptable Values/ Example Usage**	**Description**
Name	String	X		Optional: Name label given to node for KML visualization, not currently used in NEXTA
node_id	Integer		Value >= 0	Node identification number
location_x	Double			describe horizontal coordinate of a node for network visualization
location_y	Double			describe vertical coordinate of a node for network visualization
TSdiagram_x	Double			describe horizontal coordinate of a node for space-time diagram visualization, this coordinate can be different from
TSdiagram_y	Double			describe vertical coordinate of a node for space-time diagram visualization

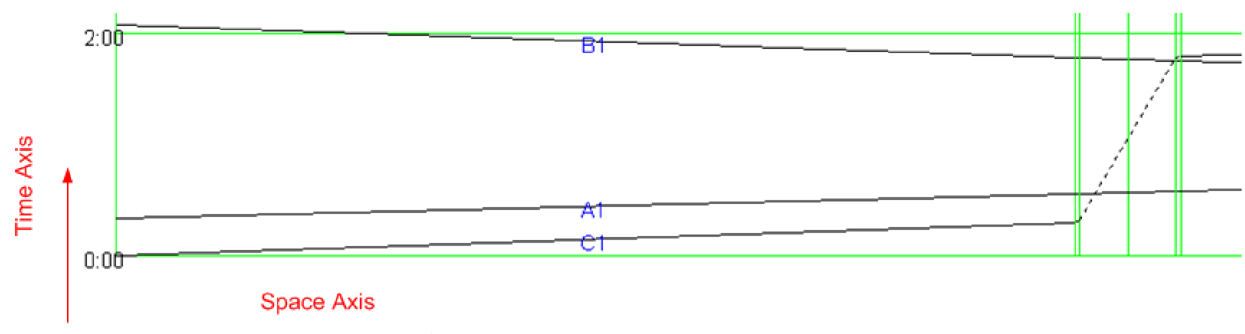
<u>Example from RAS Toy Network:</u>

name	node_id	location_x	location_y	TSdiagram_x	TSdiagram_y
0	0	0	0	0	0
1	1	18	0	18	0
3	3	19	0	19	0
5	5	20	0	20	0
6	6	40	0	40	0
7	7	58	0	58	0
8	8	59	0	59	0
11	11	60	0	60	0
12	12	80	0	80	0
2	2	18.1	1	18.1	0
4	4	19.9	1	19.9	0
9	9	58.1	1	58.1	0
10	10	59.9	1	59.9	0

Why do we use TSdiagram_x, TS_diagram_y, which are different from location coordinates in some cases?

Answer: NEXTA computes the time axis of a time-space diagram by offsetting the TSdiagram x/y coordinates of each node. Thus, a user needs to shift the physical location coordinates of those nodes on switches (e.g., node 3 and 4 in the figure below) so that the time axis of a space time diagram is aligned horizontally or vertically.

Train trajectories are shown in solid lines when they are running on main tracks, otherwise as dotted lines on switches and sidings.



input_track_type.csv [Essential input data]

The input_track_type table allows users to define their own specific track types. Link types can also be used to determine how links are visualized in NEXTA.

Variable Name	Type	Optional	Acceptable Values	Description
track_type_code	String			Optional: Name label assigned to link type in the same row, used for visualization purposes in NEXTA
name	String		0 or 1	Identifies link type as belonging to a freeway class. Only one flag may be used in each row.
max_speed	float		>o	Maximum speed for trains running this type of tracks

Example from RAS Toy Network:

track_type_code	Name	max_speed
0	First Main Track	80
1	Second Main Track	80
2	Third Main Track	80
SW	Switch	15
S	Siding	20
C	Crossover	15

input_rail_arc.csv [Essential input data]

The input_rail_arc table defines all links in the network, along with their corresponding characteristics and traffic flow model input data. Several optional fields are included for generating/converting networks for use with microscopic simulation (e.g., VISSIM).

Variable Name	Type	Optional	Acceptable Values	Description	Defined in Table
Name	String	X		Optional: Name label assigned to link in current row, used for visualization purposes in NEXTA and KML export	
arc_id	Integer		Value > 0	Arc identification number	
A_node_id	Integer		Value > 0	Identification number corresponding to the node located at the beginning of the link	(input_rail_node.csv)
B_node_id	Integer		Value > 0	Identification number corresponding to the node located at the end of the link	(input_rail_node.csv)

bidirectional_flag	Integer		1 = single-track 0 or 2= double track	Identifies the direction of travel on the link. When 1, we allow train traverse from A_node_id to B_node_id , and from B_node to A_node	
Length	Double		Value ≥ 0.00001	The length of the link (between end nodes), measured in units of miles or KM.	
track_type	String		0, 1, 2, …, S, SW, C…	Track type identification code, corresponding to track type (main track, switch, etc.)	(input_track_type.csv)
default_AB_speed_per_hour	Integer		Value > 0 mph, kmph	Speed limit on the A-> B direction defined link in units of miles or KM per hour, used to define the free-flow speed.	
default_BA_speed_per_hour	Integer		Value > 0 mph, kmph	Speed limit on the B-> A direction defined link in units of miles or KM per hour, used to define the free-flow speed.	

Example from RAS Toy Network:

name	arc_id	A_node_id	B_node_id	length	bidirectional_flag	track_type	default_AB_speed_per_hour	default_BA_speed_per_hour
	1	0	1	18	1	0	80	70
	2	1	2	0.3	1	SW	15	15
	3	1	3	1	1	0	80	70
	4	2	4	2	1	S	20	20
	5	3	5	1	1	0	80	70
	6	4	5	0.3	1	SW	15	15
	7	5	6	20	1	0	80	70
	8	6	7	18	1	0	80	70
	9	7	8	1	1	0	80	70
	10	7	9	0.3	1	SW	15	15
	11	9	10	2	1	S	20	20
	12	8	11	1	1	0	80	70
	13	10	11	0.3	1	SW	15	15
	14	11	12	20	1	0	80	70

input_train_info.csv [Essential input data]

Variable Name	**Type**	**Optional**	**Acceptable Values**	**Description**	**Defined in Table**
train_header	string			Train identification number	
entry_time	Integer		Value ≥ 0	Time in the schedule at which the train trip begins	
origin_node_id	Integer		Value > 0	Departure/origin node identification number	(input_rail_node.csv)
destination_node_id	Integer		Value > 0	Arrival/destination node identification number	(input_rail_node.csv)

direction	string	x		Direction which the train trip takes	
speed_multiplier	double		Value > 0	The train speed on each main track link = speed_multiplier* default_BA_speed or default_AB_speed e.g. default_BA_speed = 80 mph, a train travels through link B to A with a speed multiplier of 0.8, then the actual speed is 80*0.8 = 0.64. For non-main tracks, such as switches, sidings, and cross-overs, the speed_muliplier. E.g. Switch's default speed 15 mph, the actual speed is also 15 mph for all trains.	This variable is used together with speed value in input_rail_arc.csv
train_length	Double		Value >= 0; Default: 0	In output_schedule.xml, exit time is the exit time of a train's tail = exit time of the head of a train + train_length/actual speed on this link. If train_length is set to 0, then exit time refers to the exit time of a train's head directly.	This variable is used in output_schedule.xml
tob	Integer				Not used in visualization
hazmat	string				Not used in visualization
sa_status_at_origin	Integer				Not used in visualization
terminal_want_time	Integer		Value > 0		Not used in visualization

<u>Example from RAS Toy Network:</u>

train_hea	entry_time	origin_node_id	destination_node_id	direction	speed_multiplier	train_length	tob	hazmat	sa_status_at_origin	terminal_want_time
C1	0	0	12	EASTBOUI	0.75	1	75	NO	0	90
A1	20	0	12	EASTBOUI	1	2.1	75	NO	0	150
B1	0	12	0	WESTBOU	0.85	1	75	NO	-120	80

input_MOW.csv [Essential input data]

Variable Name	Type	Optional	Acceptable Values	Description	Defined in Table
A_node_id	Integer		Value >= 0	Identification number corresponding to the node located at the beginning of the link with MOW	(input_rail_node.csv)

B_node_id	Integer		Value >= 0	Identification number corresponding to the node located at the end of the link with MOW	(input_rail_node.csv)
start_time_in_min	Integer		Value >= 0	Starting time of MOW in min	
end_time_in_min	Integer		Value > 0	Ending time of MOW in min	

Example from RAS Toy Network:

A_node_id	B_node_id		
11	12	0	20

2. Output Files

output_schedule.xml [Essential output data]

Variable Name	**Type**	**Optional**	**Acceptable Values**	**Description**	**Defined in Table**
train id	string			train_header	input_train_info.csv
movement arc	string		'(%d,%d)'	A node and B node of a link used along the train path	AB or BA direction should be defined in input_rail_arac.csv
entry	int			Entry time of a train's head in seconds	
exit	int			exit time of a train's tail in seconds = exit time of a train's head + train_length/actual speed*3660 seconds/hour	

Example from RAS Toy Network:

```
<solution territory='RAS DATA SET TOY'>
        <trains>
                <train id='A1'>
                        <movements>
                                <movement arc='(0,1)' entry='1200' exit='2104.500'/>
                                <movement arc='(1,3)' entry='2010' exit='2149.500'/>
                                <movement arc='(3,5)' entry='2055' exit='2194.500'/>
                                <movement arc='(5,6)' entry='2100' exit='3094.500'/>
                                <movement arc='(6,7)' entry='3000' exit='3904.500'/>
                                <movement arc='(7,8)' entry='3810' exit='3949.500'/>
                                <movement arc='(8,11)' entry='3855' exit='3994.500'/>
```

```
                        <movement arc='(11,12)' entry='3900' exit='4894.500'/>
                        <destination entry='4800'/>
                    </movements>
                </train>
                <train id='B1'>
                    <movements>
                        <movement arc='(12,11)' entry='1200' exit='2470.588'/>
                        <movement arc='(11,10)' entry='2410.084' exit='2722.084'/>
                        <movement arc='(10,9)' entry='2482.084' exit='4129.500'/>
                        <movement arc='(9,7)' entry='3949.500' exit='4261.500'/>
                        <movement arc='(7,6)' entry='4021.500' exit='5171.079'/>
                        <movement arc='(6,5)' entry='5110.575' exit='6381.163'/>
                        <movement arc='(5,3)' entry='6320.659' exit='6441.668'/>
                        <movement arc='(3,1)' entry='6381.163' exit='6502.172'/>
                        <movement arc='(1,0)' entry='6441.668' exit='7591.247'/>
                        <destination entry='7530.743'/>
                    </movements>
                </train>
                <train id='C1'>
                    <movements>
                        <movement arc='(0,1)' entry='0' exit='1140'/>
                        <movement arc='(1,2)' entry='1080' exit='1392'/>
                        <movement arc='(2,4)' entry='1152' exit='6621.668'/>
                        <movement arc='(4,5)' entry='6441.668' exit='6753.668'/>
                        <movement arc='(5,6)' entry='6513.668' exit='7773.668'/>
                        <movement arc='(6,7)' entry='7713.668' exit='8853.668'/>
                        <movement arc='(7,8)' entry='8793.668' exit='8913.668'/>
                        <movement arc='(8,11)' entry='8853.668' exit='8973.668'/>
                        <movement arc='(11,12)' entry='8913.668'/>
                    </movements>
                </train>
        </trains>
</solution>
```