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Highway Networks and Traffic Simulations in Transims

MATH 522 – ILLINOIS INSTITUTE OF TECHNOLOGY

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Abstract

Advancements in technology and modern computers mean we can now simulate and analyze complex sociotechnical systems with hundreds of variable factors on our local computers. One such software currently in development, which can create and simulate such systems is TRANSIMS. The Transportation Analysis and Simulation System (TRANSIMS), is an integrated set of tools developed to conduct regional transportation system analyses. It uses a new paradigm of modeling individual travelers and their multi-modal transportation based on synthetic populations and their activities. Compared to other transportation aggregate models, TRANSIMS represents time consistently and continuously, as well as detailed persons and households. This paper focuses on the Installation and execution of TRANSIMS simulations, and in turn, explores the different data and control files required, the global keys and parameters of TRANSIMS, and the results they generate. This paper also goes on to study how to effectively visualize these results using a GIS software and investigates some of the capabilities of such software's.

Introduction

Metropolitan Planning Organizations often require transportation models to plan highway networks, transportation strategies and investments required. This requires simulating many complex variations like individual movements, traffic flows in certain periods of time, activity locations nearby, housing, parking lots, and a lot more. It is pretty much like simulating the movements of an entire town or city. This requires numerous calculations and a good amount of computing power. The simulations should give results in near real time with valuable insights related to network planning, traffic congestions and possible solutions. The program should also be able to effectively emulate real life movements of individuals and vehicles when given some directions and indications by the user.

The first thing required here would be data for the transportation network and a sample of simulation data to execute on this network. Such data is often available with Metropolitan Planning Organizations. Advancements in technology have helped in developing more detailed transportation models from a granular set of network data.

The simulation program for such transportation and network data and models discussed here is The Transportation Analysis and Simulation System or TRANSIMS. As part of an effort to make TRANSIMS a public resource to be used by the transportation community, TRANSIMS executables and programs are freely available online. TRANSIMS is a tool used to conduct regional transportation systems simulations and analyses and is also capable of incorporating individual travelers and their movements in its simulations to study the effects of social movements on transportation networks and provide the resultant statistics to investigate the effectiveness of the transportation network in question.

TRANSIMS modules can generally be split into 3 categories. It can take network data inputs which are manually generated or as part of a transportation software package and convert them to Node, Link and Shape files in a TRANSIMS recognized format. Next, TRANSIMS requires a set of business rules to apply on such a network to create a complete network ready for simulation. These will be discussed in later sections. The end result is validation of these network files as being suitable for trip or tour planning, routing, and microscopic simulation. The steps discussed here can generally be applied on most Networks to be simulated in TRANSIMS as most simulations in TRANSIMS result in synthetically generated data files which can be iteratively reviewed and adjusted. Manual review through examination or through any particular GIS program is an important requirement at the end of any TRANSIMS simulation.

TRANSIMS Software Installation and Required Files

Documentation on TRANSIMS can be found at https://code.google.com/archive/p/transims/ .

Although the documentation does list Linux support and certain modules can be imported in Linux, upon examination, it resulted in defunct links and a certain lack of documentation around the Linux system. As such, this document concentrates on the Windows version, and will look to add information on Linux systems later on.

The base executable files for TRANSIMS can be found on the TRANSIMS SourceForge site at: https://sourceforge.net/projects/transims/

For development purposes, it is recommended to install TRANSIMS Studio, which is similar to most modern IDE's. Installing TRANSIMS Studio inadvertently installs TRANSIMS on your system too. TRANSIMS Studio can be downloaded here: https://sourceforge.net/projects/transimsstudio/

TRANSIMS uses text files as input and output files as well as for simulation summary tables. Therefore, a text editor like notepad ,Notepad++ or Wordpad will also be required.

Data Files

Installation of TRANSIMS Studio should result in a sample network set on Alexandria, Virginia to be stored on your system under the Documents/TRANSIMS Studio folder. If not, the download link can be found here: http://sourceforge.net/projects/transims/files/test%20data/Alexandria%202008-06-10/

The downloaded dataset should be stored in a custom directory, preferably in ../Documents/TRANSIMS Studio.

After unzipping the files, the following sub directories should be available in the Alexandria folder:

- **\batch** - executable batch files which automate certain TRANSIMS procedures
- **\control** - control files that direct the operation of various TRANSIMS components
- **\demand** - contains trip tables, trip times, and vehicle types - used by TRANSIMS to generate trips
- **\inputnetwork** - text files defining nodes, links, zones, and shapes used by TransimsNet to generate the network
- **\network** - the network generated by TransimsNet will be stored here
    - **\network\arcview** - initially empty; ArcNet output will be stored here
- **\results** - initially empty; results from each model iteration will be stored here

A smaller test network on only a few square blocks is listed in the documentation as available at: http://code.google.com/p/transims/wiki/TinyExampleInfo . This link, however, is now defunct and the

TinyExample network no longer looks to be available online. The link is just mentioned here for future reference.

Tip: In case during network simulations you come across an error saying TRANSIMSRTE not found or something similar, a fix would be to find the Bin subdirectory under the Transims Studio installation folder, and add this link to the Path variable in the system environment variables. This tells the system where the Transims executables are located. The link most probably would be: C:\Program Files (x86)\TRANSIMS Studio\Bin64. If you are unaware of how to add a link to a path variable follow the directions here: https://docs.telerik.com/teststudio/features/test-runners/add-path-environment-variables

Additional datasets can either be manually created (will require substantial time and effort) or can be requested from Transport Authorities. Network traffic data can be sourced from a variety of travel demand forecasting networks or from a number of modern day utility programs.

Now that we have Transims up and running, the next section explains the basics of Transportation Networks before we look into the Alexandria dataset in Transims.

Transportation Networks

Transportation Systems have a specific structure. It is built with an interconnection map framework of pathways or roads. The characteristics of Roads depends on their purpose. All networks come in layers. Like the OSI Reference Model for the internet, Transportation Networks have a layered structure too. The layers essentially build up from the basic landscape, to the road network, to signals and schedules, to vehicles and then trips and places. The order from top-down is as follows:

- Places
- Trip Ends
- End to End Trip
- Driver/Passenger
- Service (Vehicle & Schedule)
- Signs and Signals
- Markings
- Pavement Surface
- Structure (Earth & Pavement and Bridges)
- Alignment (Vertical and Horizontal)
- Right-Of-Way
- Space

The layers are self-explanatory. Once the roads and their interconnections are planned out and built, signals are established on them which enforce right-of-way based on time and people then travel on the roads to go from Place to Place which counts as a trip.

From a Road design perspective, the following elements are required to build a map of roadways on any area of land:

- Zone Centroid - special node whose number identifies a zone, located by an "x" "y" coordinate representing longitude and latitude (sometimes "x" and "y" are identified using planar coordinate systems).
- Node (vertices) - intersection of links, located by *x* and *y* coordinates
- Links (arcs) - short road segments indexed by from and to nodes (including centroid connectors), attributes include lanes, capacity per lane, allowable modes
- Turns - indexed by at, from, and to nodes

These can be extended to have additional properties like:

- Routes, (paths) - indexed by a series of nodes from origin to destination. (e.g. a bus route)
- Modes - car, bus, HOV, truck, bike, walk etc.
- Signals
- Locations

There are many additional properties which result in a detailed network like specifying the type of road (pathway, freeway, etc.), the type of connection (pocket lane, roundabout, etc.), speed limits, etc.

Transims Network System

A Transims Network is basically a collection of files which define the various aspects of a transportation network like the Nodes, Links, Highways, Signals, etc. Based on the desired function, not all files may be required but are necessary for a detailed granular simulation of a transportation network. It is possible to create the data for each file manually or through a custom code, but it is not recommended since it is a highly time-consuming process. Transims has a utility called TransimsNet which works to convert the raw Input Node and Link files to generate a synthesized Transims formatted network as output. Although, previous versions have used NetPrep too in this regard, in Transims 7, it looks like Netprep and TransimsNet have merged their functionalities into TransimsNet itself.

The Figure below shows the high level data flow to construct a Transims Network:

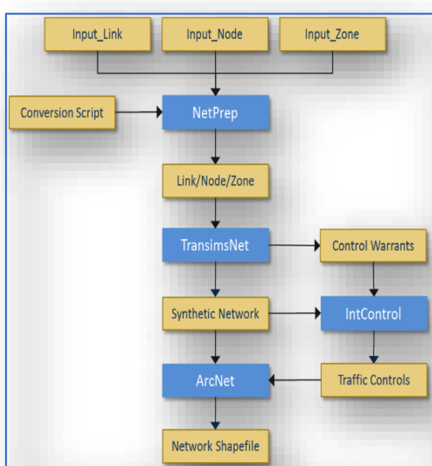

Figure 1 - High Level flow of Transims Network Simulation

The Input and Output files are labeled in brown and the Transims utilities are labeled in blue.

Input and Output Files:

Transims requires multiple data files, usually in text format as input to its utilities. The table below summarizes each file

Table 1 - Files Associated with TRANSIMS

Typical Filename	Purpose	How the file is typically created
Input_Node.txt	Nodes for the network	From an existing planning model or GIS database
Input_Link.txt	Links for the network	From an existing planning model or GIS database
Input_Zone.txt	Zone centroids for the network	From an existing planning model or GIS database
Input_Shape.txt	Shape points for the links in the network	Netprep (formerly GISNet) is used to create this shape file from an .shp shape file
Turn_Prohibition.txt	Optional file of turn restrictions and penalties	From an existing planning model
Node.txt	Nodes for the network	Netprep conversion from Input_Node.txt
Link.txt	Links for the network	Netprep conversion from Input_Link.txt
Zone.txt	Zone centroids for the network	Netprep conversion from Input_Zone.txt
Shape.txt	Shape points for the links in the network	Netprep conversion from Input_Shape.txt
Location.txt	Locations on the network where flow enters or exits. These take the place of zone centroids	TransimsNet
Parking.txt	Parking lots	TransimsNet
Process_Link.txt	Process links	TransimsNet
Pocket.txt	Pocket lanes	TransimsNet
Connection.txt	Connections within intersections	TransimsNet
Lane_Use.txt	Optional file of lane use restrictions and tolls	Manually created
Sign_Warrants.txt	Nodes that should have stop or yield controls	TransimsNet
Signal_Warrants.txt	Nodes that should have traffic signals	TransimsNet
Sign.txt	Nodes with stop or yield controls	Intcontrol
Signal.txt	Nodes with signals	Intcontrol
Timing_Plan.txt	Timing plans for the signals	Intcontrol
Phasing_Plan.txt	Phasing plans for the signals	Intcontrol
Detector.txt	Detectors for the signals	Intcontrol

The Input_Node/Link/Shape files are the data files of a road network as taken from a geographic system. The Input_Node file contains the Node number and coordinates for each node and the Input Link file does the same for links along with mentioning the from and to node. The Shape file is the result of a .shp file which defines the polygon shapes of various parameters of the network.

TransimsNet (Netprep and TransimsNet) process these files and convert them into a format recognized by Transims to create a synthesized road network layer. Intcontrol is used to process Signaling data and finally all this data is sent to ArcNet to create the Network Shapefiles which is the set of final Network shapefiles with all inclusive parameters surrounding the transportation network and ready for simulation in Transims or any GIS platform.

```
Input_Node.txt - Notepad
File  Edit  Format  View  Help
NODE      X_COORD Y_COORD Z_COORD NOTES
70        323528.40       4295812.30      0.00
71        321737.40       4295204.20      0.00
72        321064.00       4295556.40      0.00
73        319234.40       4296197.90      0.00
74        314407.90       4295778.60      0.00
75        313471.00       4296153.70      0.00
76        313381.20       4297015.60      0.00
77        312854.80       4297804.20      0.00
78        313876.00       4298859.30      0.00
79        314145.00       4299033.60      0.00
```

Figure 2 - Snapshot of Inout_Node.txt

```
Input_Link.txt - Notepad
File  Edit  Format  View  Help
LINK    STREET  ANODE   BNODE   LENGTH  TYPE    LANES_AB        SPEED_AB        LANES_BA        SPEED_BA        USE
1       CAPITAL BELTWAY 3920    2545    144.1   FREEWAY 4       30      0       0       CAR/TRUCK/BUS
2       CAPITAL BELTWAY 3920    999     145.4   FREEWAY 0       0       4       30      CAR/TRUCK/BUS
3       GEORGE WASHINGTON MEMORIAL      3921    2746    69.4    EXPRESSWAY      3       19      0       0       CAR/BUS
4       GEORGE WASHINGTON MEMORIAL      3921    2744    70.8    EXPRESSWAY      0       0       3       19      CAR/BUS
5       HENRY G SHIRLEY MEMORIAL        3929    796     82.7    FREEWAY 2       32      2       32      HOV3/HOV4/BUS
6       EXTERNAL        87      2783    148     EXTERNAL        2       15      2       15      ANY
7       EXTERNAL        88      3725    155     EXTERNAL        3       15      3       15      ANY
9       HENRY G SHIRLEY MEMORIAL        3929    3723    85.9    FREEWAY 0       0       4       30      CAR/TRUCK/BUS
10      EXTERNAL        86      2747    108.3   EXTERNAL        2       15      2       15      ANY
11      EXTERNAL        83      1000    234     EXTERNAL        1       11      1       11      ANY
13      HENRY G SHIRLEY MEMORIAL        3929    3722    375     FREEWAY 6       30      6       30      CAR/TRUCK/BUS
14      HENRY G SHIRLEY MEMORIAL        3929    212     83.5    FREEWAY 4       30      0       0       CAR/TRUCK/BUS
17      EXTERNAL        76      3630    216     EXTERNAL        2       15      2       15      ANY
19      HENRY G SHIRLEY MEMORIAL        3926    3019    300     FREEWAY 6       30      6       30      CAR/TRUCK/BUS
20      DUKE    3927    2054    92.8    BRIDGE  2       11      0       0       ANY
21      DUKE    3927    2052    90      BRIDGE  0       0       2       11      ANY
```

Figure 3 - Snapshot of Input_Link.txt

Transims Utilities

TransimsNet

The TransimsNet program uses basic link and node information to synthesize the data fields and network files needed by TRANSIMS. The remaining network file contain additional information about the network like pocket lanes, activity locations, connectivity links, parking lots and traffic control information. Parking Lots are the start and end point of every vehicle in a Transims Simulation. The program also optimizes Node and Link information and updates lane and speeding information for the network.

In a TRANSIMS Network, trips start and end at activity locations which are always associated with a link. They are generally at the side face of the specified link. The individual trip can start or end by walking from the intersection node to the activity link. Parking Lots are a type of activity link which act as start and end points for all vehicles. TRANSIMS automatically creates parking lots on the appropriate type of road if needed.

TransimsNet also generates lane information on links and generates pocket lanes which are used to connect lanes at an intersection. Pocket lanes are essentially turn lanes. Lane connectivity records ultimately holds this information. TransimsNet also processed turn prohibition files and updates lane entry and exit information accordingly. The program then processes the resultant network to create sign and signal information in Sign_Warrants and Signal_Warrants.

Example of TransimsNet from Alexandria:

```
TransimsNet = ControlKeys ( 'TransimsNet' )
TransimsNet.FromString ( """
    #---- Input Files ----
    NET_DIRECTORY                       ../inputs
    NET_NODE_TABLE                      Input_Node.txt
    NET_ZONE_TABLE                      Input_Zone.txt
    NET_LINK_TABLE                      Input_Link.txt
    NET_SHAPE_TABLE                     Input_Shape.txt
    NET_TURN_PROHIBITION_TABLE          Turn_Prohibition.txt
    KEEP_NODE_LIST                      Keep_Node_List.txt

    #---- Output Files ----
    NEW_DIRECTORY                       ../@ALT@/network
    NEW_NODE_TABLE                      Node
    NEW_ZONE_TABLE                      Zone
    NEW_LINK_TABLE                      Link
    NEW_SHAPE_TABLE                     Shape
    NEW_ACTIVITY_LOCATION_TABLE         Activity_Location
    NEW_PARKING_TABLE                   Parking
    NEW_PROCESS_LINK_TABLE              Process_Link
    NEW_POCKET_LANE_TABLE               Pocket_Lane
    NEW_LANE_CONNECTIVITY_TABLE         Lane_Connectivity
    NEW_UNSIGNALIZED_NODE_TABLE         Sign_Warrants
    NEW_SIGNALIZED_NODE_TABLE           Signal_Warrants
    NEW_TURN_PROHIBITION_TABLE          Turn_Prohibition
    LINK_NODE_EQUIVALENCE               Link_Node
```

Figure 4 - Snapshot of TransimsNet Keys (a)

```
#---- Parameters -----

POCKET_LENGTHS_FOR_FACILITY_1         100, 150, 150, 150, 300, 350, 400, 500      //---- meters ----
POCKET_LENGTHS_FOR_FACILITY_2         60, 75, 75, 75, 150, 200, 250, 300
POCKET_LENGTHS_FOR_FACILITY_3         40, 50, 50, 50, 80, 100, 125, 150
POCKET_LENGTHS_FOR_FACILITY_4         30, 40, 40, 40, 70, 80, 90, 100
POCKET_LENGTHS_FOR_FACILITY_5         30, 40, 40, 40, 70, 80, 90, 100
POCKET_LENGTHS_FOR_FACILITY_8         60, 75, 75, 75, 150, 200, 250, 300
POCKET_LENGTHS_FOR_FACILITY_9         60, 75, 75, 75, 150, 200, 250, 300
POCKET_LENGTHS_FOR_FACILITY_10        60, 75, 75, 75, 150, 200, 250, 300

SIGNAL_WARRANT_FOR_AREA_TYPE_1        COLLECTOR, LOCAL, TIMED
SIGNAL_WARRANT_FOR_AREA_TYPE_2        COLLECTOR, COLLECTOR, TIMED
SIGNAL_WARRANT_FOR_AREA_TYPE_3        MINOR, COLLECTOR, ACTUATED
SIGNAL_WARRANT_FOR_AREA_TYPE_4        COLLECTOR, COLLECTOR, ACTUATED
SIGNAL_WARRANT_FOR_AREA_TYPE_5        MAJOR, MINOR, ACTUATED
SIGNAL_WARRANT_FOR_AREA_TYPE_6        MAJOR, MAJOR, ACTUATED
SIGNAL_WARRANT_FOR_AREA_TYPE_7        PRINCIPAL, MAJOR, ACTUATED
SIGNAL_WARRANT_FOR_AREA_TYPE_8        PRINCIPAL, PRINCIPAL, ACTUATED

STOP_WARRANT_FOR_AREA_TYPE_1          LOCAL
STOP_WARRANT_FOR_AREA_TYPE_2          COLLECTOR
STOP_WARRANT_FOR_AREA_TYPE_3          COLLECTOR
STOP_WARRANT_FOR_AREA_TYPE_4          COLLECTOR
STOP_WARRANT_FOR_AREA_TYPE_5          COLLECTOR

ACTIVITY_LOCATION_SIDE_OFFSET         15             //---- meters ----
MAXIMUM_ACCESS_POINTS                 3
MINIMUM_SPLIT_LENGTHS                 60, 60, 60, 60, 60, 60, 60, 60      //---- meters ----
MINIMUM_LINK_LENGTH                   7.5            //---- meters ----
MAXIMUM_LENGTH_TO_XY_RATIO            1.2
INTERSECTION_SETBACK_DISTANCE         7.5            //---- meters ----
FIRST_EXTERNAL_ZONE_NUMBER            70
COLLAPSE_NODES_FLAG                   TRUE
ADD_UTURN_TO_DEADEND_LINKS            YES
""" )
```

Figure 5 - - Snapshot of TransimsNet Keys (b)

Upon running the TransimsNet executable, the resultant network files are stored in the network directory. They can be inspected by a GIS software or manually to correct any errors in the network. The errors can also be corrected in any GIS software

IntControl

The IntControl program uses intersection configuration and lane connectivity data to populate the traffic control files required by TRANSIMS. The sign and signal control files as a result of TransimsNet identify the intersections that require traffic controls. The program then creates and validates controls for signalized and unsignalized nodes. This includes the timing plan, phasing plan, detectors, and signal coordinator files. The green signal time is allocated on various factors like number of lanes, intersection type, etc.

Again, the results of this stage require manual review, either through a GIS software or manually to check the signaling data generated by the program.

Intcontrol execution and its input and output files location are the same as TransimsNet.

ArcNet

The ArcNet utility converts the TRANSIMS network to a series of ArcView shapefiles that can be displayed and edited in ArcGIS or other mapping software. It generates an ArcView shapefile representation of most of the TRANSIMS network files. The generated data can be edited and reloaded into mapping software or be edited directly in certain mapping softwares like ArcGIS or QGIS. The utility can also convert coordinates from UTM meters to the state plane coordinate system or the latitude-longitude system for integration with other data sources.

ArcNet can be applied in a number of ways for a number of purposes. It does not need to convert all of the TRANSIMS network files at one time. Most conversions will need to include at least the link and node files to provide geographic references for displaying data objects that are defined based on link-offsets.

The ArcView shapefile will have the same name as the input network files with extensions “shp,” “shx,” and “dbf.” The *.shp and *.shx files are binary files that include the shape coordinates and index data. The *.dbf file is the dBase file that includes the data fields from the TRANSIMS data file.

A GIS program such as ArcGIS/ArcMap, or QGIS can display these files in map format. Some examples using the Alexandria dataset are explained in later sections.

Execution using the Alexandria dataset

Transims Studio

As mentioned before, the first step would be to locate the Alexandria dataset which can be ideally found in ../Documents/TRANSIMS Studio.

To run-through the basic utilities and generate a Transims network of Alexandria, you can proceed in 2 ways. In the first approach, open the project in TRANSIMS Studio by selecting open project in the IDE and then going to ../Documents/TRANSIMS Studio/Alexandria/RTE and opening Alexandria.prj. This is a project file and will generate the project contents in TRANSIMS Studio. Now to generate the basic network, open Advanced Scripts and files in the Project Files section:

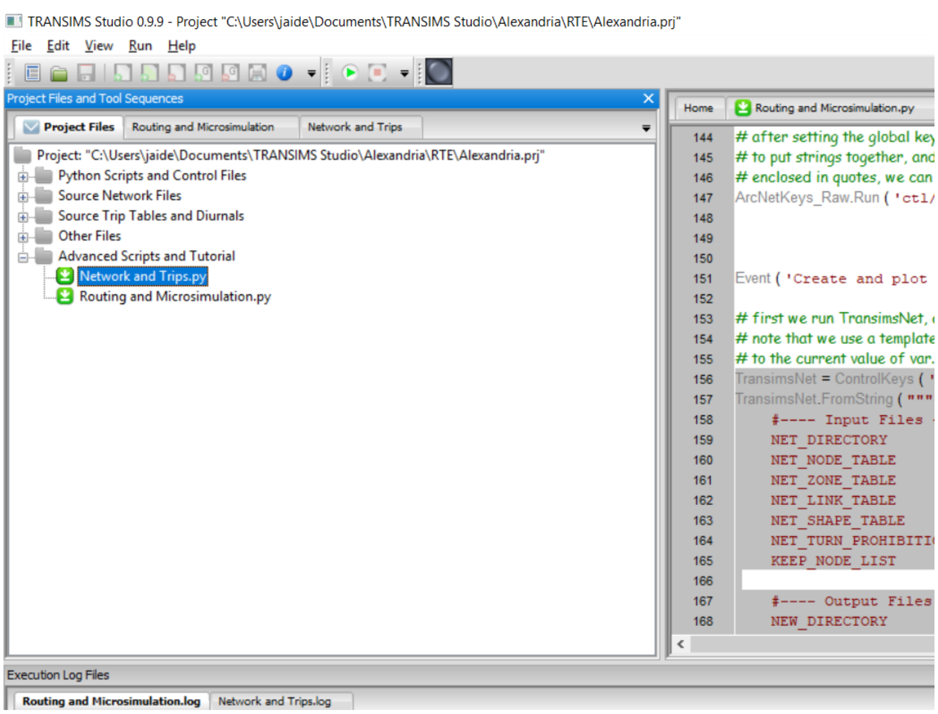

Figure 6 - Snapshot of Alexandria in TRANSIMS Studio

Examine the two python files in this section. The first file, Network and Trips.py edits the Global keys for TransimsNet, IntControl and ArcNet to generate a synthesized Transims network and stores it in the Alexandria folder under BASE_MODEL. Global keys are just attributes of the Transims utility in question. The results can be examined, once the script has finished its execution, in the popup that appears.

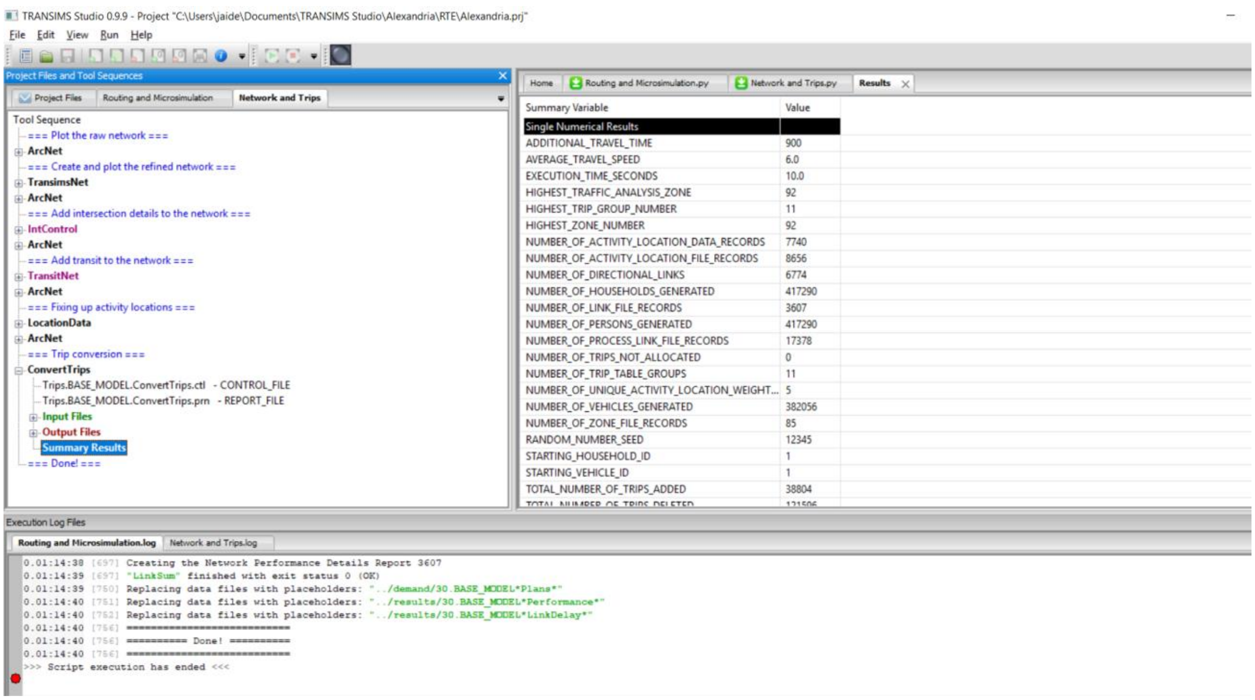

Figure 7 - Execution Summary of Network and Trips.py

You can edit the parameters in the python file to generate different results.

The other file, Routing and Microsimulation, runs a full-scale traffic simulation on the data generated above and generates statistics around congestion rate, delays, efficiency, travel miles, trip routes, etc. The results are shown below:

Summary Variable	Value
Single Numerical Results	
AVERAGE_LINK_DENSITY	1.92
AVERAGE_LINK_MAX_DENSITY	25.42
AVERAGE_LINK_TIME_RATIO	0.91
AVERAGE_MILES_PER_HOUR	33.2
AVERAGE_QUEUED_VEHICLES	8386.67
CONGESTED_TIME_RATIO	3.0
EXECUTION_TIME_SECONDS	2.0
MAXIMUM_QUEUED_VEHICLES	75873.0
MINIMUM_LINK_VOLUME	2
NUMBER_OF_CYCLE_FAILURES	35629.0
NUMBER_OF_DIRECTIONAL_LINKS	6774
NUMBER_OF_LANE_MILES	762.84
NUMBER_OF_LINKS	6460.0
NUMBER_OF_LINK_FILE_RECORDS	3607
NUMBER_OF_ROADWAY_MILES	324.52
NUMBER_OF_TURNING_MOVEMENTS	0.0
PERCENT_OF_LINK_DIRECTIONS_WITH_TRAVEL_TIME...	95.3
PERCENT_OF_LINK_TIME_PERIODS_WITH_TRAVEL_TI...	94.4
PERCENT_TIME_CONGESTED	2.32
PERCENT_VHT_CONGESTED	15.48
PERCENT_VMT_CONGESTED	3.42
SUMMARY_TIME_INCREMENT	60
VEHICLE_HOURS_OF_DELAY	13132.48
VEHICLE_HOURS_OF_TRAVEL	35127.08
VEHICLE_MILES_OF_TRAVEL	1166107.3
Single Non-Numerical Results by Partition	
CONGESTED_TIME_RATIO_UNIT	loaded ti...
CONTROL_FILE	C:/Users/...
DEFAULT_FILE_FORMAT	TAB_DELI...
EXECUTION_TIME_STRING	0:00:02
FRI_NOV_30_13:04:46_2018__	Process ...
LINK_DELAY_FILE	../results...
LINK_FILE	../BASE_...
MINIMUM_LINK_VOLUME_UNIT	vehicles/...
NETWORK_DIRECTORY	../BASE_...
NUMBER_OF_LINK_DELAY_FILE_RECORDS	[1480717,...
PROJECT_DIRECTORY	../
REPORT_FILE	C:/Users/...
SUMMARY_TIME_INCREMENT_UNIT	minutes
SUMMARY_TIME_PERIODS	6:00..19:00

Figure 8 - Summary of Microsimulation of Alexandria Transportation Network

All these results are stored in the same directory as the Alexandria data files on your system.

The second approach to run this case would be to follow the instructions in the Readme file in the Alexandria folder. This should run similar executions to the scripts mentioned above but without the need for an IDE. On trial however, this method crashed halfway with multiple errors and fixes could not be found online. One fix that initially is needed to run this is mentioned on Page 5 of this document under the Tip section.

QGIS/ArcGIS

There are several Geographic Information Systems (GIS) software's available online that can take Transims Network shape files as input and depict the Roadworks and additional properties visually. These softwares take the output generated by the 3 utilities mentioned above in terms of the shape files. Shape files are a set of multiple files consisting of the following extensions:

- .shp file containing the feature geometries

- .dbf file containing the attributes in dBase format
- .shx index file

If you explore the BASE_MODEL folder generated now in the Alexandria data folder, you will see several such files, notably for the Nodes, Links, Signals, Parking and Activity Locations. We will explore how to visualize these files both in QGIS or ArcGIS.

QGIS

In QGIS, open the Add vector Layer option under the Layer menu or simply press *ctrl + shift + v* . Then under source browse to the following directory:

../Documents/TRANSIMS Studio/Alexandria/BASE_MODEL/network/arcview

Now press *ctrl+a* to select all the files in this folder and add them as layers to QGIS. Once the software has finished processing you should see a visual roadwork map of Alexandria on your screen.

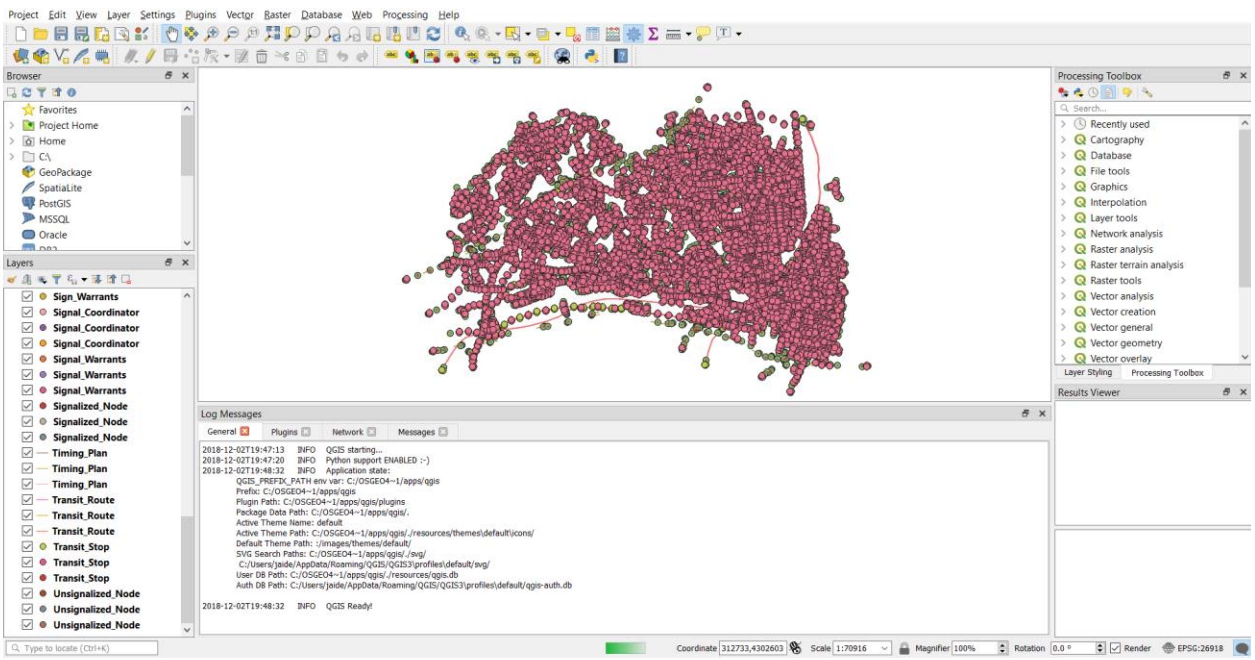

Figure 9 - Snapshot of Alexandria TRANSIMS Network in QGIS

You can add or remove layers from the panel in the left menu. Each layer is a part of the network calculated in steps above. You can see the Parking Lots, Signal locations, Nodes, links, Activity Locations and much more. Here is a zoomed in section of a street:

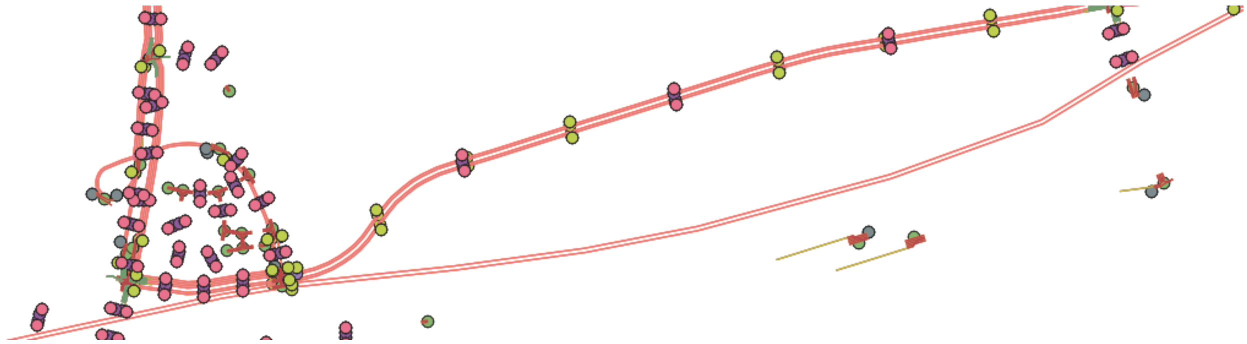

Figure 10 - Zoomed-in Intersection with Activity Location as colored dots

In Figure 9 on the upper right menu you can see a Processing Toolbox. This contains a variety of processing functionalities at your disposal, mainly things like summary statistics, nearest neighbor, and shortest path. The results of such analyses are shown visually and when needed on the map itself. For example, if you look at the shortest path option, the GUI allows you to select 2 points on the map and displays the shortest path visually.

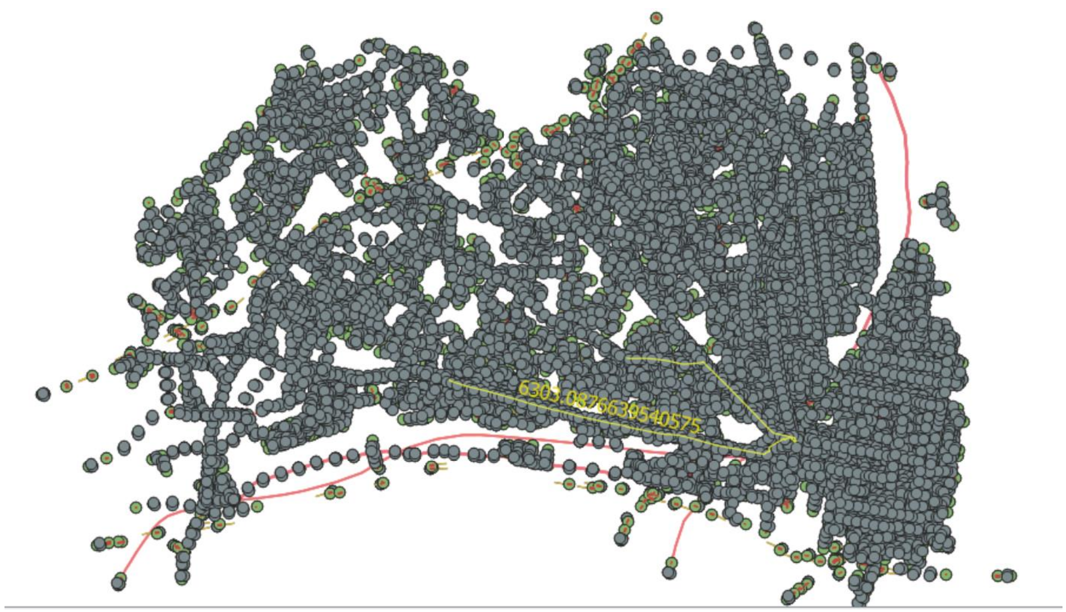

Figure 11 - Yellow line showing shortest route

The yellow highlighted path in this map is the shortest distance between the 2 endpoints. This functionality has several tweaks that are possible, namely the type of vehicle, average speed, etc. and the shortest path changes accordingly.

There are a variety of other analyses and simulation options available on QGIS. It also has the advantage of being open source and free to download. QGIS can be found here: https://www.qgis.org/en/site/

ArcGIS

ArcGIS is an alternative GIS tool to QGIS. The similar Alexandria map can be pulled up in ArcGIS Pro by adding a new map and then adding the layers in a similar fashion to QGIS under the .. menu. The corresponding map looks like this:

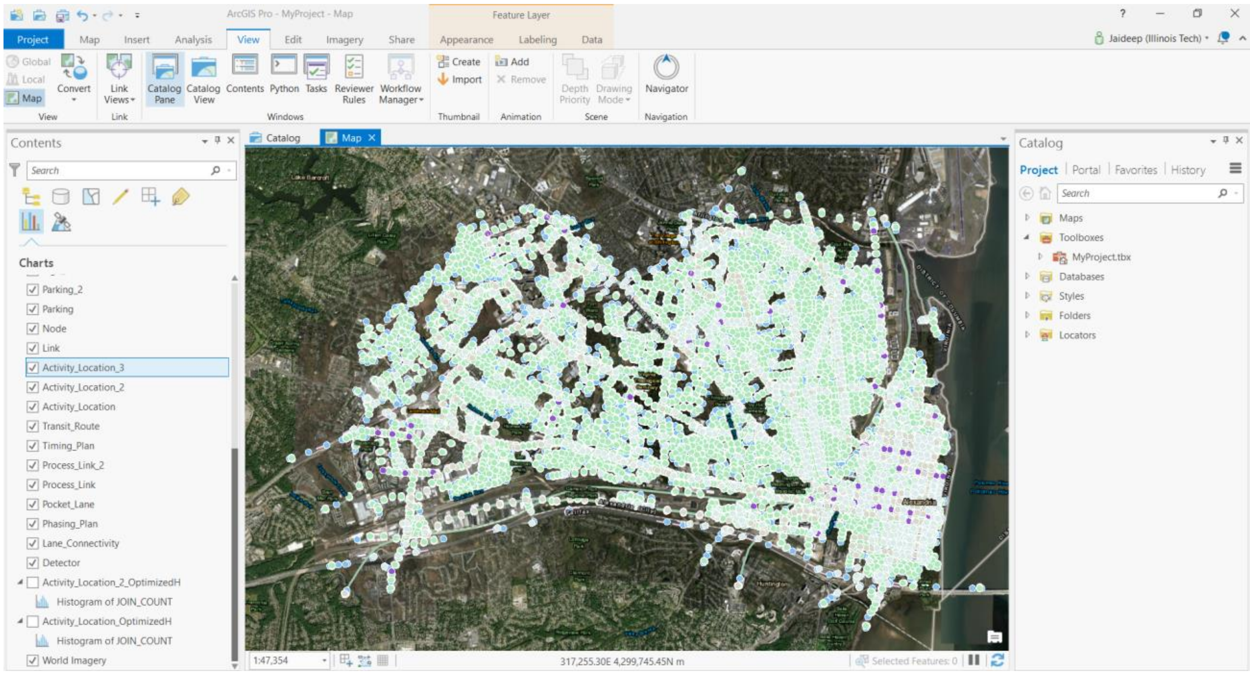

Figure 12 - Snapshot of Alexandria TRANSIMS Network in ArcGIS

With a zoomed in view of an intersection:

Figure 13 - Zoomed in view 1

Figure 14 - Zoomed in view 2

As you can see, the resulting map is richer and overlays the network on World Imagery of the map of Alexandria. ArcGIS has similar processing functions like QGIS in its toolbox. Since it is an advanced proprietary software, it has various additional features too. It can run a complete simulation on the traffic network overlaid here and generate the 'congestion hotspots', i.e. it can show where traffic congestions are frequent and higher than the other areas (in red) along with the corresponding summary statistics. You can do this by selecting a particular layer for congestion analyses like for example a category of Activity Locations (points where trips start and end according to Transims). The results are shown below:

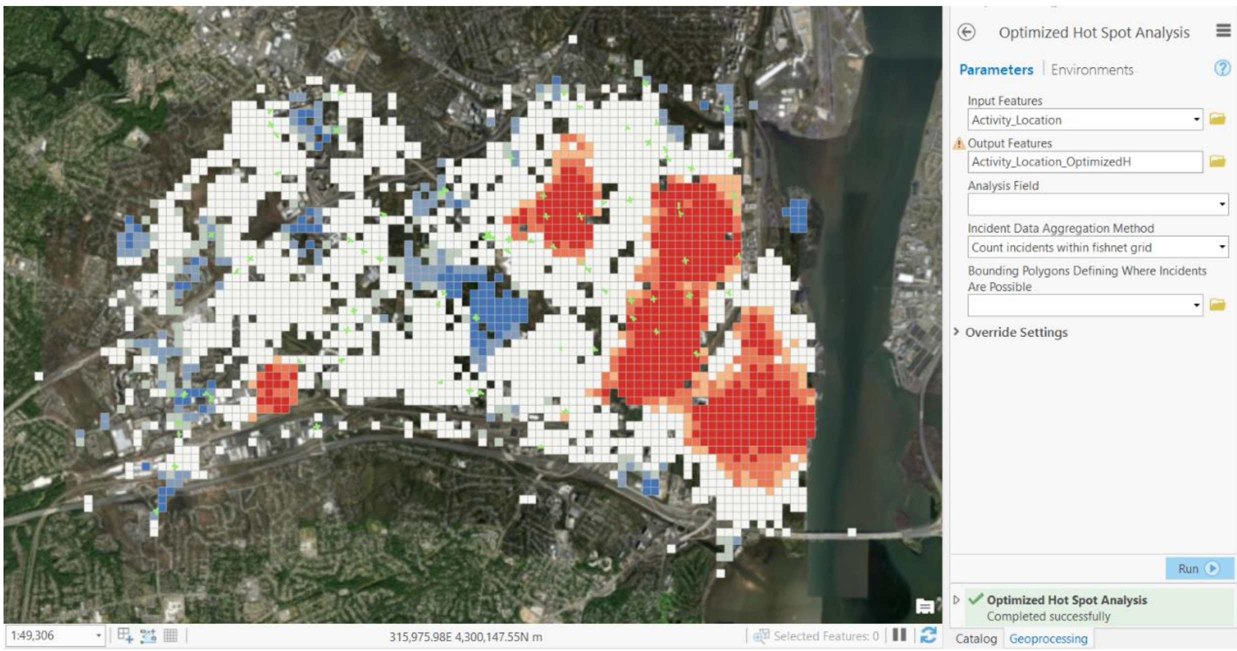

Figure 15 - Congestion Heat map of Alexandria

As you can see, the red spots are on the river front which is likely downtown Alexandria. Statistics on congestions can be seen by clicking on the red spots.

ArcGIS has several advanced processing functions which makes it a sought-after application. The software however requires a proprietary license which must be purchased. It can be found here: https://www.arcgis.com/home/index.html. A free trial for ArcGIS can be found here: https://www.esri.com/en-us/arcgis/products/arcgis-pro/trial.

Conclusion

Transims and Transims Studio is an excellent piece of software to develop, model and simulate traffic models. The functionalities are well-thought of the simulations are usually accurate representations of a real-world scenario. The lack of documentation or tutorials on the project however is worrisome and it would take a significant amount of time and effort to learn the uses of this software without the complete documentation on its inner workings.

QGIS and ArcGIS are highly recommended GIS tools which are easy to operate and can process complex graphic visualizations with ease. They are compatible with Transims network shape files and can modify any errors in them visually.

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