Demo paper: AGADE-TRAFFIC

Multi-Agent Simulations in Geographical Networks

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Abstract. AGADE-TRAFFIC is a tool for simulating traffic flow in networks. Traffic participants are modelled as NetLogo agents and are visualised in a graphical user interface. Geographic information is stored in a graph database and AGADE-TRAFFIC communicates with that database through a NetLogo extension. Routing capabilities of the database are used while respecting the current traffic situation that is continuously reflected into the database. Different models of congestion effects are available and can be investigated in flexible traffic assignment models. Real world networks can be imported from Open Street Map. The tool allows the definition of specific cost and pricing schemes so that effects of selfish routing and social optimisation can be compared.

Keywords: Multi-Agent Simulation Routing, Traffic Assignment, Graph Databases, Traffic Simulation, Congestion Effect

1 Introduction

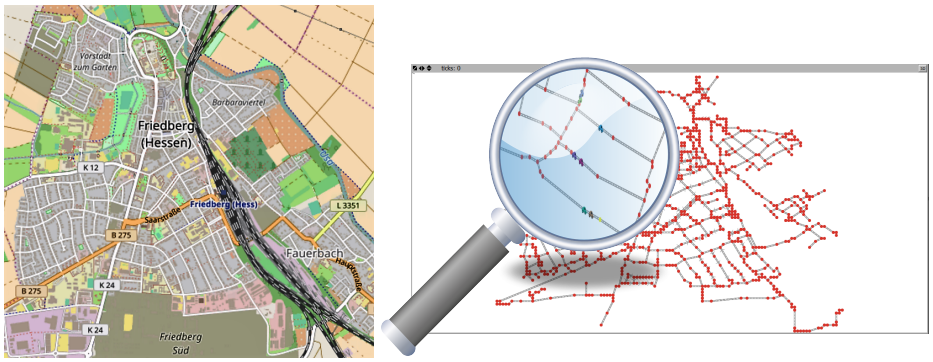
AGADE-TRAFFIC is a tool for simulations of traffic flow in traffic networks with individuals travelling from origins to destinations that can freely be defined. Its main purpose is the examination of the overall traffic behaviour and effects on objective functions defined globally, typically mean or average travel times. With an easy to use Netlogo front-end it allows an intuitive approach for interactively setting up simulations. AGADE-TRAFFIC has an integrated interface to the Neo4J graph database via a two-way service layer implemented as a NetLogo extension. The graph database contains geographic information imported from Open Street Map (OSM). Other than comparable tools like TrafficGen (see [1]) AGADE-TRAFFIC aims at simulating large scale scenarios to model the overall traffic flow rather than the individual behaviour in more detailed traffic situations e.g. overtaking. For this purpose AGADE-TRAFFIC reflects traffic to the graph database so that the routing algorithms always consider the current traffic distribution. The architecture can run in a distributed environment using the distribution mechanisms of the database.

2 Main purpose

AGADE-TRAFFIC allows elaborate experiments with congested traffic assignment (see [5]). The tool can be used to simulate congestion effects in traffic networks through appropriately calibrated functions that describe congestion dependant travel times which are defined on the route segments i.e. the edges of the graph that represents the network. Individuals always choose optimal routes according to cost functions that considers travel times and possible additional external costs. The interface to the routing algorithm of the graph database can be adapted so that different congestion functions and pricing schemes can be used and those already pre-defined can easily be adapted for changing scenarios. The tool can therefore be used to model different concepts of traffic control i.e. different pricing schemes for tolling or centrally controlled route assignment to find equilibria in the traffic system and to fine tune the process of mechanism design to create optimal traffic assignments.

3 Demonstration

AGADE-TRAFFIC uses NetLogo agents to model the flow of traffic in a network of roads. Start and end of journeys can be set through the interface as well as the amount of individual traffic participants on each origin destination relation can be defined there. The agents travel on shortest routes which are calculated by the graph database using an integrated implementation of the A*-algorithm. The position of each agent is immediately reflected to the database so that the calculations respect the amount of traffic on each segment. Speed and travel time can either be determined by a simple linear function or by a parameterised BPR function (see for example [3]).



(a) OSM extract of Friedberg (b) NetLogo Screenshot

Fig. 1. Real world map integrated in Netlogo.

AGADE-TRAFFIC uses a NetLogo extension to establish a bidirectional communication with the database to retrieve geographic information to draw a map in which traffic is visualised, for initialising and retrieving results from routing calculations and for perpetually updating the positions of the agents in the database.

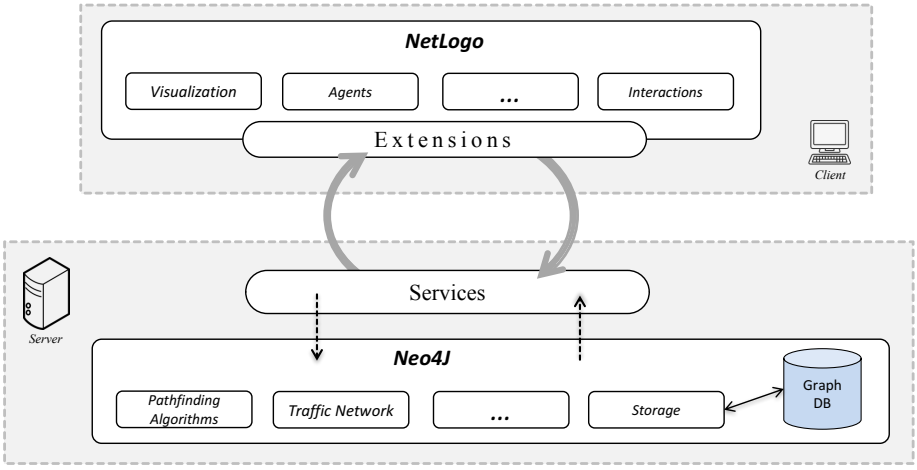


Fig. 2. Architecture.

AGADE-TRAFFIC uses geographic information imported and transformed from OSM by means of OSMSOSIS (see [6]) and the OSMToNeo4JConverter which is built by that project on top of the Neo4J Spatial extension (see [4]). During this conversion necessary information taken from OSM is transferred into properties of the components of the graph structure in Neo4J.

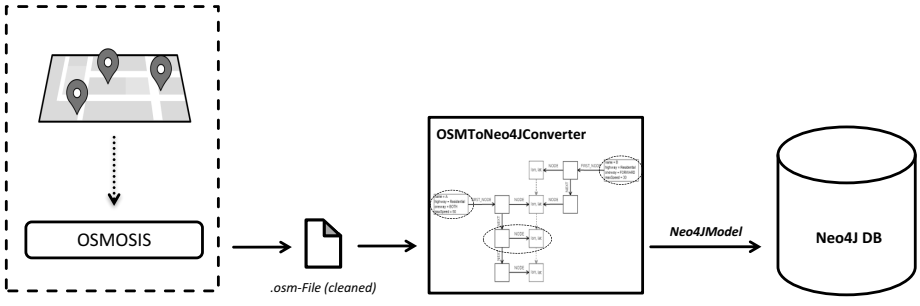


Fig. 3. Import process OSM to Neo4J.

The advantage of using the graph database lies in its natural representation of links and nodes which can well be used for a basic representation of the geographical network and beyond that in its ease to model additional abstract information about the network e.g. maximum speed and derived capacities of route segments. Upon that it offers routing mechanisms that are efficiently implemented in the database. However, a more systematic benchmarking of the integration is still a task to be carried out and is part of the future work of this project.

4 Conclusion

In this demonstration paper, we have presented an architecture that integrates NetLogo with a graph database through a NetLogo extension. Overall traffic flow and congestion effects in networks can thus be investigated interactively. Besides the necessary benchmarking already mentioned before future work will consist of a full integration of AGADE and its semantic modelling capabilities (see [2]) to elaborately model individual decision patterns of traffic participants. This will allow scenarios in which the influence of individual decisions on the overall flow of traffic can be examined in depth. Possible decisions to be modelled are for example the choice of route depending on preferences like cheapest over fastest, use of public transport rather than individual motor car traffic, car or ride sharing. We can then create scenarios that use CO_2 production as objective function and relate the results to individual transport preferences.

References

1. Bonhomme, A., Mathieu, P., Sébastien, P.: A versatile multi-agent traffic simulator framework based on real data. International Journal on Artificial Intelligence Tools (2016)
2. Farrenkopf, T., Guckert, M., Urquhart, N.: AGADE using personal preferences and world knowledge to model agent behaviour. In: Demazeau, Y., Decker, K.S., Pérez, J.B., de la Prieta, F. (eds.) Advances in Practical Applications of Agents, Multi-Agent Systems, and Sustainability: The PAAMS Collection - 13th International Conference, PAAMS 2015, Salamanca, Spain, June 3-4, 2015, Proceedings. Lecture Notes in Computer Science, vol. 9086, pp. 93–106. Springer (2015)
3. Mtoi, E.T., Moses, R.: Calibration and evaluation of link congestion functions: Applying intrinsic sensitivity of link speed as a practical consideration to heterogeneous facility types within urban network. Journal of Transportation Technologies (2014)
4. Neo4J-Contributors: Neo4j spatial is a library of utilities for neo4j that faciliates the enabling of spatial operations on data. `https://github.com/neo4j/spatial` (2017), accessed
5. Ortuzar, J., Willumsen, L.: Modelling Transport. Wiley (2011)
6. Osmosis-Contributors: Osmosis is a command line java application for processing osm data. `https://wiki.openstreetmap.org/wiki/Osmosis` (2017)