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MODELING OF GEOMETRIC REPRESENTATION THE OBJECTS IN CAD SYSTEMS

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Abstract. This article describe the main ways of solutions for the transport problems, with the most effective way is to increase the connectivity of the road network by constructing new roads, which makes it possible to redirect road flows around congested areas and to give drivers a greater choice of routes. First of all, the obvious solution is to ramp up the capacity of existing roads with additional lines and the urban planners have provided reserve space for such renovations, otherwise there will simply be nowhere to expand the highway. The allocation of high occupancy lines, as well as lines for public transport, brings significant results only if there is a tangible and inevitable punishment for violators and in some cases it can even further reduce the average speed, that is be the actual problem.

Keywords: models, transport flows, microscopic models, cellular automation, multi-agent models.

Introduction. There are many possible solutions for the transport problems. The most effective way is to increase the connectivity of the road network by constructing new roads, which makes it possible to redirect road flows around congested areas and to give drivers a greater choice of routes. Next obvious solution is to ramp up the capacity of existing roads with additional lines. This is only possible in case if the urban planners have provided reserve space for such renovations, otherwise there will simply be nowhere to expand the highway. The allocation of high occupancy vehicle (HOV) lines, as well as lines for public transport, brings significant results only if there is a tangible and inevitable punishment for violators, and in some cases it can even further reduce the average speed.

Microscopic models

The computing power of modern computers grow increasingly in accordance with Moore's law, programming languages and developer tools do also not lag behind in this evolutionary race.

Today advances in computing, make possible to create microscopic transport models which are considered to be a different type of transport models. It is logical to imitate not the movement of the entire automobile flow, but the movement of particular cars; it is not so difficult to emulate one, two, or even a dozen vehicles in terms of performance, but not hundreds as this is just one of the many reasons that researchers of the fifties of the XX century were forced to work with flow abstractions.

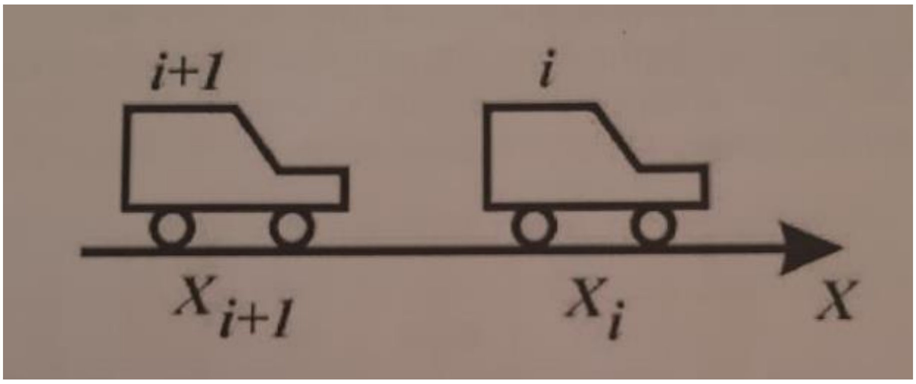

Figure *1*. – The concept of a leader following model

"Follow the leader" models are the simplest class of microscopic models among all types of transport models. The road network is represented by a road graph, the lines of which can have a fixed speed limit. Each car is represented by an individual object with a small set of variable parameters (speed, acceleration) and unchanged properties (length, maximum speed, etc.). If crossroads are included in the model, a simple traffic light control model should also be provided. The main idea is that the movement of the car can only be affected by the vehicle in front of it: the car at the head of the column holds the maximum speed, while those following it are forced to adapt to the speed of the leader.

The following equation can be used to calculate the position and parameters of each vehicle with respect to the column leader:

$$\acute{x}n(t + \tau)= \lambda\ (\acute{x}n\_1(t) - \acute{x}\ (t)),$$

where t is simulated time, τ is driver reaction time, and xn – position of nth-car . The socalled sensitivity coefficient λ may depend on various parameters, including the distance between the cars and the speed of the nth car. If we turn to McClure's work "Industrial Mathematics", it can be argued that for $\lambda\tau \leq \pi$ the flow is stable, whereas $\lambda\tau > \pi$ it is unstable. The "optimal speed" model can be one of the various existing variations of this method. It suggested the following behavior of the car: while the distance to the next car exceeds a certain threshold, it maintains maximum speed; when this threshold is passed, the car will slow down and try to adjust its speed to the vehicle in front of it. Wiederman went further and proposed the introduction of four states in which the car may be present:

–Free movement – the most probable state of the leaders of the columns (if there are any), in this case, the remaining participants in the movement do not affect the car;

–Approach – adaptation of the speed of the vehicle as it approaches the vehicle ahead;

–Follow – the driver follows the car ahead and tries to maintain optimal speed and distance;

–Braking – a quick deceleration when the front-going vehicle drastically reduces speed for any reason.

The disadvantage of this type of model in its pure form is the lack of built-in mechanisms that support the use of multiline roads. Despite this, there are a huge number of implementations of models of this type, which allow researchers to carry out many experiments on a discrete transport stream.

For the first time, these models made it possible to simulate controlled crossroads and car lines, as well as elucidate the phenomenon of “phantom traffic jams”.

Cellular automation

Roads in the real world can consist of more than one lane in one direction.

At the moment, the use of cellular automata, which make it possible to simulate multi-lane highways, is the most popular method of microscopic modeling of transport.

The main idea is to represent roads in the form of numerical matrices where each row corresponds to a strip, each cell corresponds to a section of a road of a fixed length, most often about it is seven meter long roads. Some numbers in the matrix mean cars moving at the appropriate speed, with the help of others empty sections of roads, crashes and other obstacles can be encoded.

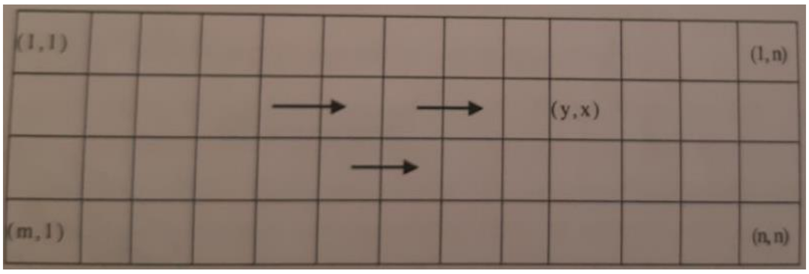

Figure *3*. –Road section in the representation of the finite state machine method

The model is drawn up step by step by applying a certain set of rules to each cell, such as “move forward n cells”, if there are no obstacles and slow vehicles ahead, or “change lane and move forward n-1 cells”, etc.

The strength of this method is the lack of differential calculations, there is not even a need for real numbers, only basic operations on integer values. Fully formalized models may even have a set of precalculated actions for a set of possible situational patterns; in this case, the system only needs to select the appropriate rule for the matrix area around the “car” and rewrite it with a “response” from the library of actions to obtain the position of the car in the next step.

Nagel and Shrekenberg described the first implementation of a transport model on cellular automata in 1992; it was very simple and simulated only one lane. Since then, methods based on cellular automata have been recognized as the most appropriate and effective for modeling traffic flows, most of the models currently under development are based on this approach.

They are already being used to analyze the effectiveness of crossroads and complicated traffic, but there is a problem, in such models, it is not possible to assign individual goals to individual cars, and it is of great importance in studies of city-scale traffic flow.

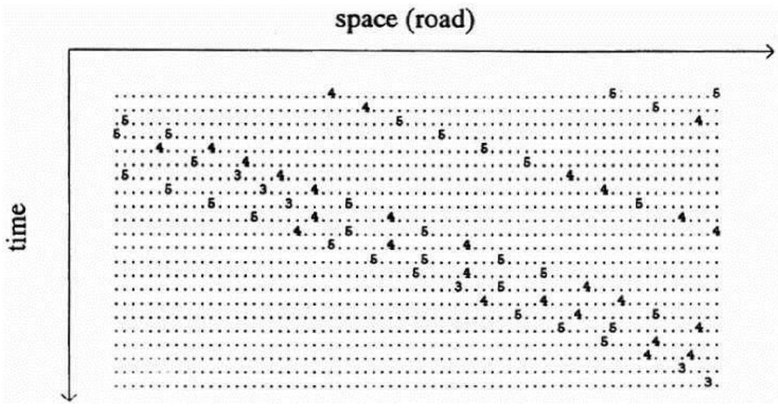

Figure *4*. –Spatio-temporal diagram of a model on cellular Nagel-Schreckenberg automata

There are additional disadvantages, for example - it is impossible to contain a lot of information about one car in one cell of the matrix, as a result of which all cars in the model have the same physical and behavioral properties. Such a limited environment does not allow simulating the individuality of each vehicle, but there is an approach to circumvent this limitation which is known as a multi-agent modeling.

Multi-agent models

In agent-oriented transport models, the main object is the driver (which, in most cases, can be combined with their vehicle into a single entity). Each driver with a car can have a wide range of individual parameters: dynamic characteristics of the car, environmental impact, information on driver habits and even their current mood, which allow to take into account the psychological characteristics of various cultures (which really affect traffic, judging by recent research).

The disadvantage of this method is the greatest complexity of the model among all considered, as well as high requirements for computing systems, but today it is an acceptable price.

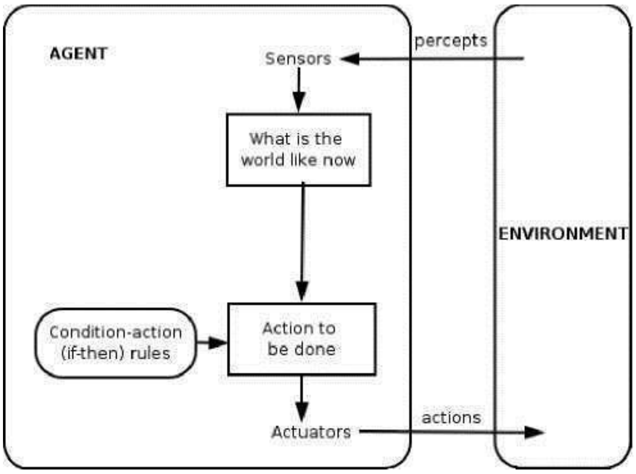

Figure 5. – Agent concept

One of the most interesting features of multi-agent systems is the interaction between agents. Each agent from the point of view of other agents is a “black box” with unknown parameters and unpredictable intentions.

Agents are forced to act in accordance with the current environment (information about which may be incomplete: the driver may not see through the buildings and may not know the exact asphalt resistance coefficient), taking into account signals from other agents and parameters available to the naked eye (each driver must somehow evaluate the speed of the surrounding vehicles). Each agent "thinks" of himself as a real driver, their actions are not determined by someone from outside, the information internal and external to the agent is processed using an expert system that gives a conclusion about the action that will be performed by the driver in the next step.

The expert system contains a knowledge base formed by the developer of the model during the analysis of the real experience of driving people; this information can be obtained through surveys, conversations with drivers, or even by collecting telemetry from vehicles

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КАРКАСНОЕ МОДЕЛИРОВАНИЕ ДЛЯ ГЕОМЕТРИЧЕСКОГО ПРЕДСТАВЛЕНИЯ ДЕТАЛЕЙ В САПР-СИСТЕМАХ

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Аннотация. В данной статье описаны основные пути решения транспортных проблем, при этом наиболее эффективным способом является повышение связности дорожной сети за счет строительства новых дорог, что дает возможность перенаправлять дорожные потоки вокруг перегруженных территорий и предоставлять водителям больший выбор маршрутов движения. Прежде всего, очевидным решением является наращивание пропускной способности существующих дорог дополнительными линиями, и градостроители предусмотрели резервные площади для таких реконструкций, иначе просто некуда будет расширять магистраль. Выделение линий повышенной загруженности, а также линий для общественного транспорта, приносит значительные результаты только в том случае, если есть ощутимые и неизбежные наказания для нарушителей, а в некоторых случаях это может еще больше снизить среднюю скорость, что является актуальной проблемой..

Ключевые слова: транспортные потоки, микроскопические модели, клеточная автоматизация, мультиагентные модели.