Regional Traffic Assignment by ACO

Preliminary Results

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An established research line in ACO systems supports the intuition that ant algorithms are particularly fit for dynamic optimization problems because of their ability to construct an internal representation of the essential elements of the problem to solve, a representation which needs to be updated and not reconstructed when the instance changes.

Our work is about one such case arising in public authorities control and planning functions, where the availability of modeling tools which support both queries on the current state and simulation and optimization when forecasting is essential for territorial processes management and control. In the framework of a research line on road traffic simulation and forecast we implemented an ACO model targeted at real-world traffic flow simulation at a regional scale.

Traffic flow simulation is a well-known research topic, which has lead to a significant theoretical corpus and to effective marketed packages. Nevertheless, the current state of the art is not yet fully satisfactory for local government agencies, especially for medium sized ones, because of operational constraints and inherent rigidity of currently available models and software.

The core problem to face is the so-called *Traffic Assignment Problem* (TAP), which determines traffic flows on the roads given an Origin - Destination (OD) matrix describing the vehicle movements. The TAP can be modeled as a combinatorial optimization problem with a nonlinear objective function, and is particularly tricky because the flow levels on the roads are a function of the flows themselves (traffic flows divert from congested, i.e. high flow, roads).

ACO modeling, meaning with this the ability of ACO systems to construct a model of the instance to solve by means of trail distribution, is particularly suited for the TAP. The general flow distribution is dictated by Wardrop's principles [1], but physical road parameters are not enough to fully determine all chosen paths. This is where ACO trail become central: physical road properties are considered in the attractiveness computations, but the resulting congestion level is implicitly modeled in the trail distribution.

We report results obtained at a province (regional in the literature) level, in a setting which is rather common for this type of application, featuring a GIS-based road network, with a superimposed region zoning decomposing the area of interest into about 60 zones, each of which corresponds to a row/column of an OD

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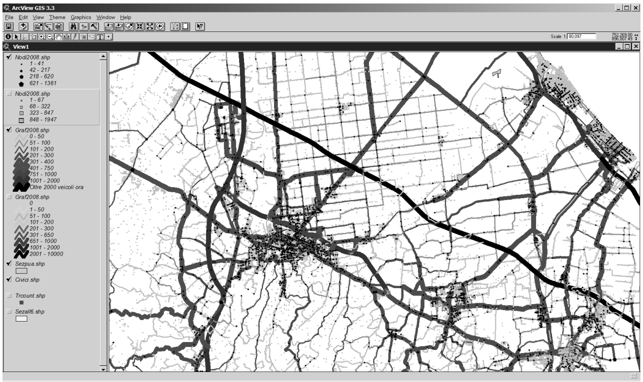

Fig. 1. Validated simulation results

matrix. Moreover, we had over 100 geocoded points, where actual traffic counts are available. The ants are called to determine flows so to minimize a global cost, which is given by the sum of the costs on arcs, where costs are a function of the flows themselves. Along the iterations, trail is added to divert flows from the paths that appear to be the least time ones, but that turn out not to be such once they are chosen by too many travelers. The general workings of our solution bears strong similarities with the Internet packet-routing applications [2], but a number of structural differences make a direct translation of packet-routing codes infeasible.

First results are available on a road network of the Italian province of Forlì - Cesena. To get actual data, we interfaced our code with the GIS of the Forlì-Cesena province, directly accessing the shapefiles it is based upon, thereby obtaining interoperability with the province's GIS. The network, along with validated simulation results, is shown in figure 1. Results validation is made against the data available as forecasts of traffic flows following the infrastructural scenarios for the next 20 years. The model implicit in the trail distribution permits to extend the assessment of non/physical road arcs, which can be determined when calibrating against known data, also to future scenarios, where calibration data is obviously unavailable. Thus, trail distribution does not only support a warm start on modified instances, but truly enables forecasting for future scenarios.

References

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