

The proposed project can be situated in the domain of GIScience. The central aim of GIScience is the optimisation of GISystems. Since humans prefer reasoning with qualitative data to reasoning with quantitative data, qualitative data – and the corresponding relations – constitute an essential part of the queries to ask to a GISystem. Topological relations are a subgroup of the group of qualitative relations and comprise the basis of most GISystems. In the early 90's, two standard theories were developed: the RCC-Calculus [1] and the 9 Intersection Model [2]. Both theories define eight topological relations between two regions in the two-dimensional space. In many situations (e.g. moving people, moving animals, moving cars), moving objects can only be represented by *disconnected from* in RCC (= *disjoint* in the 9 Intersection Model). This approach ignores certain important aspects of reasoning about continuous moving physical objects. Consider, for instance, two trains driving on the same track; here it is of vital importance to know their movement with respect to each other, for example to find out whether they would crash in the future. Despite the fact that the above mentioned widespread theories certainly have proved their importance, both the RCC Calculus and the 9 Intersection Model can not differentiate further between *disconnected from/disjoint* objects; nor indeed could any purely topological representation. Thus, an essential question yet to be answered was: 'How do we handle changes of movement between moving objects, if there is no change in their mutual topological relation?'

In [3], the Qualitative Trajectory Calculus (QTC) was introduced. QTC is a calculus for representing and reasoning about moving point objects in a qualitative manner. QTC allows a distinction to be made between different groups of disjoint moving. The basic principle of QTC is the central idea that the complex reality of moving objects can be greatly simplified by describing the interaction between two permanently disjoint point objects. Depending on the level of detail and the number of spatial dimensions, different types of QTC are defined, all belonging to QTC-Basis (QTC_B) or QTC-Double Cross (QTC_C). In QTC_B [4], only the changing distance between two objects is taken into account, independent of the number of dimensions in which the movements take place. QTC_C [5] considers in addition the movement direction of the objects. The reasoning power of QTC was demonstrated by means of different reasoning techniques, such as conceptual neighbourhood diagrams [6] and composition tables [7]. For illustration of the applicability of QTC, different simplified cases have been worked out manually (e.g. [5]). Currently, research is done in extending QTC to QTC_S and QTC_N. QTC_S [8] is a calculus to describe the shapes of polygons and spatial configurations of vectors. QTC_N [9] is a calculus concerning movements of point objects along networks in a so-called codimensional space.

Initially, QTC was introduced to handle relations between pairs of moving disjoint point objects. Yet, it is evident that reality is much more complex. Therefore, in the proposed project we aim to represent, reason about and query more complex evolutions of objects in 3D (2D space + time). We believe that such a complex model can constitute the basis for an intelligent 4D spatiotemporal GIS.

In order to reach this goal, the objects are to be generalized to real geographical entities that are much more faithful to reality. QTC will be generalized by eliminating the following simplifications:

- As noted before, many problems about the motion of objects can be solved without considering the size of an object. Therefore, an arbitrary point (e.g. the centroid) is taken as the spatial location of an object. However, there are many occasions when we do need

to consider the size and shape of an object, e.g. cars moving on a car park or cars standing still in a queue.

- So far, we have ignored all RCC relations apart from the *disjoint*-relation. However, there are occasions when different topological relationships need to be considered.

- So far, it is assumed that the object identity is stable and that the shape of the objects does not change. Extensions need to be made to be able to handle such kinds of changes as well.

- So far, only objects having sharp boundaries (e.g. the border between two municipalities, the boundary of a building) were studied. The model also needs to support vague boundaries (e.g. the edge of a city, the boundary of a cloud).

The above mentioned research tasks will be optimally geared to each other. Specific attention will be paid to fuzzy modelling.

In order to test the model, some illustrative case studies will be worked out.

REFERENCES

[1] Randell, D., Cui, Z, and Cohn, A.G., 1992, A spatial logic based on regions and connection, KR, 165-176.

[2] Egenhofer, M. and Franzosa, R., 1991, Point set topological spatial relations, International Journal of Geographical Information Systems, 5 (2), 161-174.

[3] Van de Weghe, N., 2004, Representing and reasoning about moving objects: a qualitative approach, PhD thesis, Ghent University, Faculty of Sciences, Department of Geography, Promoter: De Maeyer, P., pp.168 + attachments (pp.100) (Thesis and presentation of defence, see: <http://users.ugent.be/~nvdewegh/#PhDTheses> (password: NVdW))

[4] Van de Weghe, N., Cohn, A.G., De Tré, B., and De Maeyer, P., 2006, A qualitative trajectory calculus as a basis for representing moving objects in Geographical Information Systems, Control and Cybernetics, 35 (1), 97-120.

[5] Van de Weghe, N., Cohn, A., De Maeyer, P., and Witlox, F., 2005, Representing moving objects in computer-based expert systems: the overtake event example, Expert Systems with Applications, 29 (4), 977-983.

[6] Van de Weghe, N. and De Maeyer, P., 2005, Conceptual neighbourhood diagrams for representing moving objects, CoMoGIS, LNCS, (3770), 228-238.

[7] Van de Weghe, N., Kuijpers, B., Bogaert, P. and De Maeyer, Ph., 2005, A qualitative trajectory calculus and the composition of its relations, GeoS, LNCS, (3799), 60-76.

[8] Kuijpers, B., Moelans, B., and Van de Weghe, N., 2006, Qualitative polyline similarity testing with applications to query-by-sketch, indexing and classification, ACM-GIS, 11-18.

[9] Bogaert, P., Van de Weghe, N., Cohn, A.G., Witlox, F., and De Maeyer, P., 2007, The Qualitative Trajectory Calculus on Networks, Spatial Cognition, LNAI, 20-38.