Life and motion configuration

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1 INTRODUCTION

Spatio-temporality is key research issue in Geographic Information Science (Yuan and Hornsby 2007). It is crucial to develop efficient spatio-temporal (ST) reasoning processes to fully exploit incredible ST information sources. A solution is to integrate time to existing qualitative spatial reasoning models such as RCC (Randell, Cui et al. 1992) or 9-intersection (Egenhofer 1989). However, there exists others way to develop ST reasoning models. As mentioned in (Kontchakov, Kurucz et al. 2007), it is sensible to develop ST reasoning models based on the description of ST shapes. Nevertheless, limitations occur. For instance, most of trajectories descriptions models postulate that moving objects do not share the same place during their evolution. Secondly, most of the models consider only coexisting objects. However, it could happened that one of the studied object disappear for a while. Finally, using theses models requires implementing new ST operators. We propose a ST reasoning model valid for coexisting and non coexisting moving objects. At this stage of the research, objects are assimilated to points. The paper is structured as follow. First we present the concept of "ST states" and their representation. Then, we construct life and motion configurations by combining theses "ST states". Finally, we conclude.

2 SPATIO-TEMPORAL MODEL AND REPRESENTATION

2.1 Spatio-temporal states

ST evolution of objects can be rather complex; it is not limited to sharing or not common place during their evolution. Questions like existence, appearance, presence… occur: does a baby exist before his birth? Will this retired soccer player play again…? We gather notions of *existence*, *presence* and *spatial interaction* between two objects at a given time into a concept called "ST state". Considering that there is a time period where an object has not yet existed and one where it will not exist anymore and that an object could not revive, we introduce the notion of existence between two objects at a given time; four possibilities occur between points A and B: A does not exist and B does not exist {∄A∧∄B}, A exist and B does not exist {∃A∧∄B}, A does not exist and B exist {∄A∧∃B} and finally, A and B exist {∃A∧∃B}. When existent, an object can be *present* or not (e.g. an existing object that is out of the analysed space, or not visible). As a result, other specific combinations appear; no presence of object A is denoted by (A). When two objects are present (and therefore are existent), it becomes possible to consider spatial interactions between them at a given time. Topological relationships have been selected to characterise these interactions. At a given time, two possibilities occur between points A and B: A and B are equal {e} or A and B are disjoint {d}. Combining all these different possibilities regarding dependence relations between concepts, we obtain ten possible states between two objects (Fig. 1) and a decision tree which is a JEPD set: {e}; {d}; {(A)}; {(B)}; {(A)(B)}; {∄A ∧B}; {∄A ∧(B)}; {A ∧∄B}; {(A) ∧∄B} {∄A ∧∄B}.

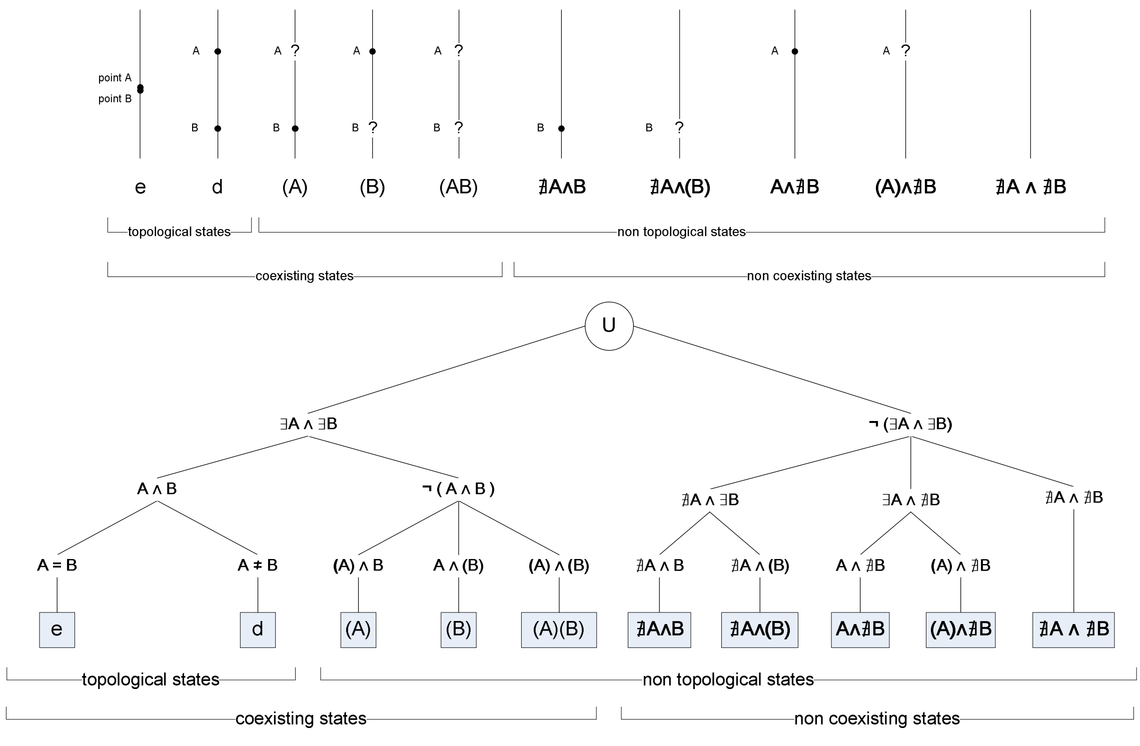

Fig. 1. Top: representation of the 10 possible “states” between two points with absence and non existence properties. (Question marks represent non present objects). Bottom: decision tree of the ten possible “states”..

2.2 Conceptual neighbourhood diagram

Following conceptual neighbourhood diagram (CND) theory (Freksa 1991), we may say that *two states are conceptual neighbourhood if an only if there is a continuous evolution between them without any intermediary states*. However, moving from an existence state to a non existence state is only possible once as we assume that a “dead” object can not revive. The CND is structured consequently; top layer concerns the non coexisting cases and bottom layer the coexisting cases. When moving from the bottom layer to the top layer, there is no way down….Two kinds of transitions are possible within the CND (see figure 2); the ones that can be repeated many times (continuous lines) and the ones can be only crossed one time in each way (dashed lines).

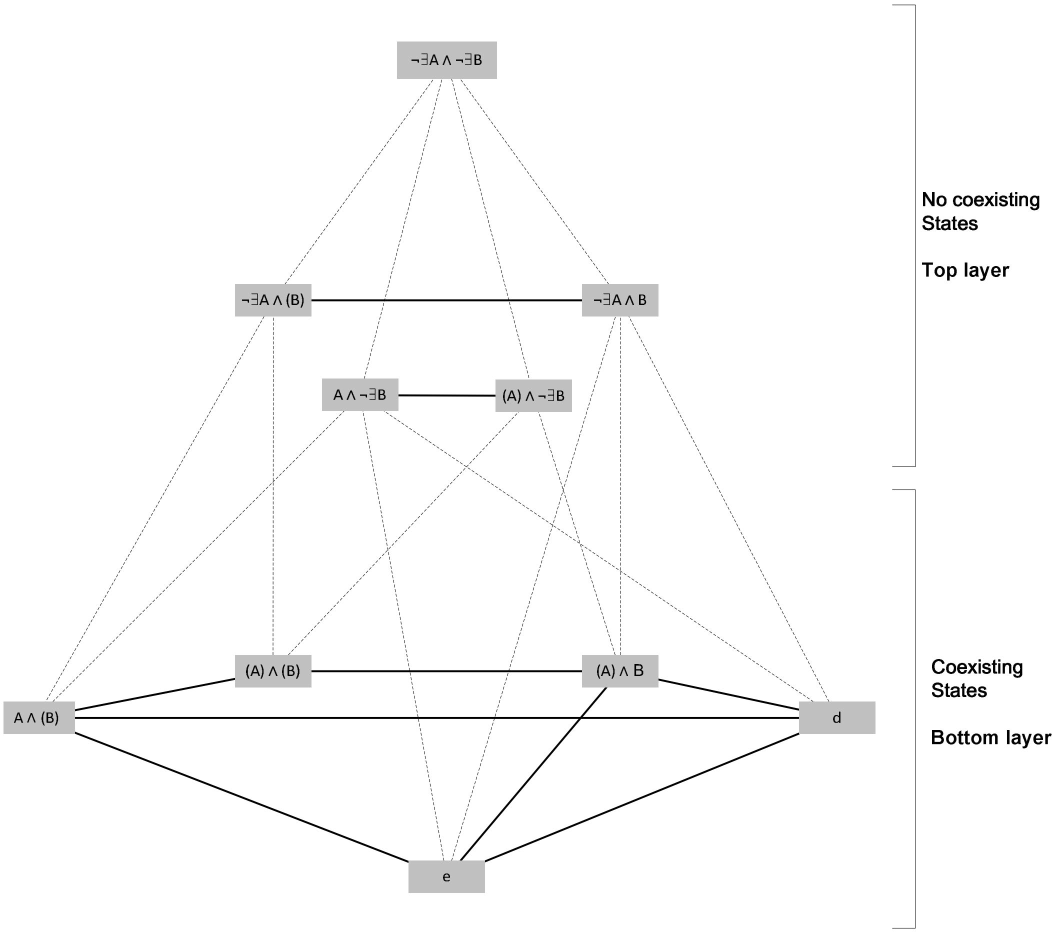

Fig.2. Conceptual neighbourhood diagram of the ten ST states..

3 LIFE AND MOTION CONFIGURATIONS

According to Hayes (Hayes 1990), (ST) regions traced over time are termed *spatio-temporal histories*. ST history of a point object is a line, continuous or not depending on object's presence. There is infinity of life and motion configurations when considering ST histories in a ST space (one axis being time and the others being related to the Euclidean space dimension where points move). However, it is possible to characterise (summarize) ST histories using a set of successive states ordered in time. Possible successions of states will define a finite number of spatial configurations. The life and motion configuration representation of ST histories is done adopting a degenerated notion of ST space where the space axis is limited to the representation of three positions to have efficient visual expression of topological relationships disjunction and equality (fig. 3).

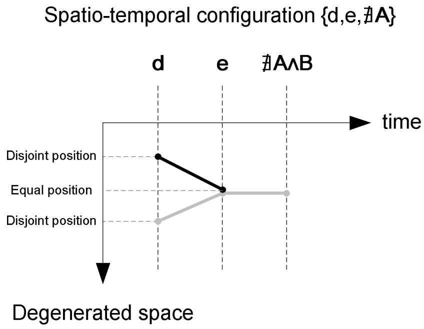

Fig.3. The life and motion configuration {d,e, ∄A }represented using a degenerated temporal space.

The set ε of states is composed by (e_1, e_2, …, e_{10}), the ten possible state values. They are combined a finite number of time n which is what we call the level of the life and motion configuration. Life and motion configurations are denoted as $\{e_1,e_2,\ldots,e_n\}$. There exist 4 continuous life and motion configuration at level 2, 88 at level 3, 778 at level 4… When considering non continuous ST histories, the number of ST configuration blows, e.g. for level 2 there is 100 configurations… 127269 for level 6…

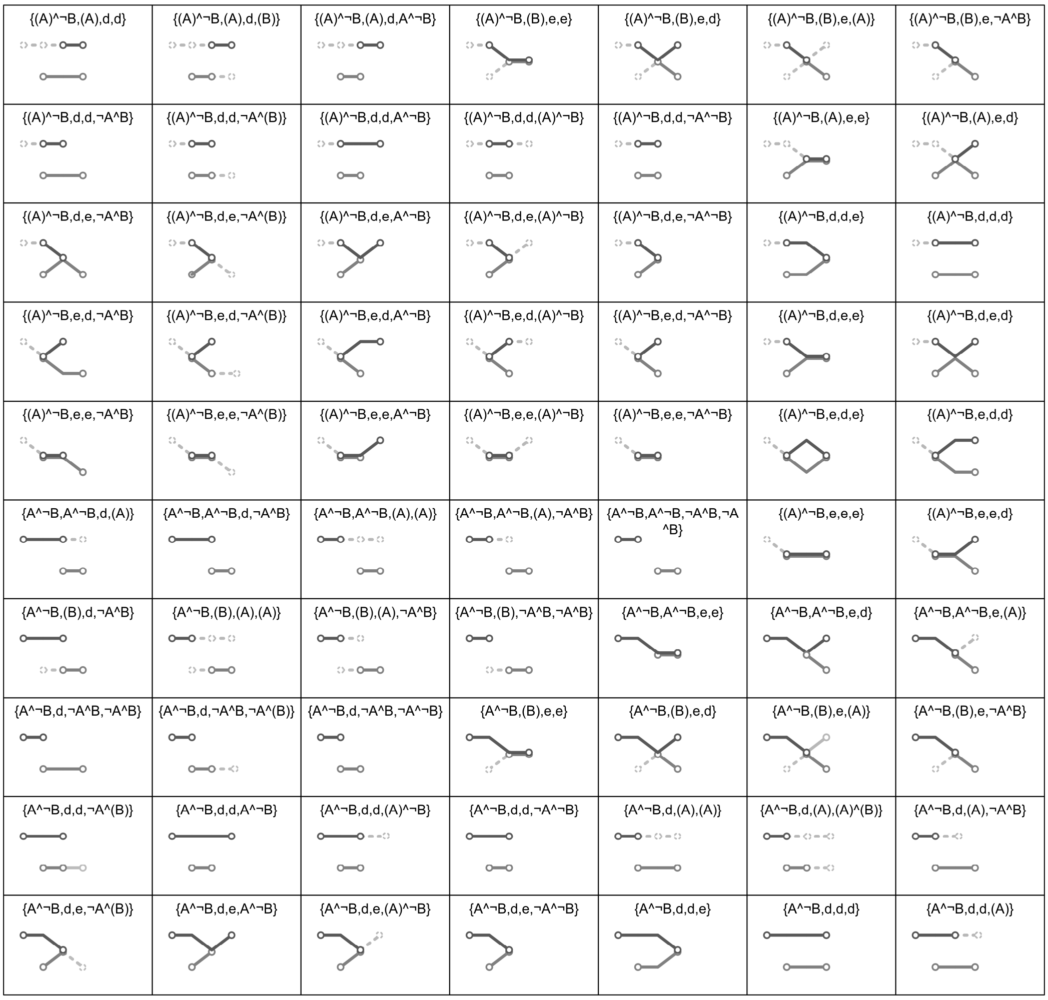

Fig.4. Extract of the life and motion configuration of level 3. The spatial axis of the temporal space is vertical and the temporal one horizontal.

3 CONCLUSION

We have proposed an extended temporal representation of existence and presence of objects. We have used this representation combined with topological concepts between objects to define ST states, i.e. *particular ST relationships between two objects at a given time*. We ended up with ten possible states which are a JEPD set and we sketched their CND. Based on this new representation, life and motion configurations, i.e. *all the possible interaction between two points in a topological and temporal point of view*, have been created to formalize ST histories. Future researches will be to check our model‘s validity with real dataset and propose generalization in a primitive space.

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