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Modeling Herd Trajectory Data Warehouse

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Abstract*— Studding the movement of animals and their behavior become an important subject. Indeed, such study can generate useful information used next to assist the decision makers involved in different domains such as agriculture, security, health care and business. We present in this work a trajectory model related to the displacement of the herd, which allows the generation of trajectory data that is going to be stored into trajectory data warehouse. The animals in the herd change continuously their location, so the collected information varies over the space and the time. To facilitate their study we present the herd by a point so we focus on the moving points. Such supposition facilitates the modeling of the trajectory.

Keywords*— Trajectory DataWarehouse (TrDW), modeling, herd, displacement, movement, animal, Star schema.

1. INTRODUCTION

The information, related to the study of a moving object during its displacement, is almost of time very useful in various domains, we can mention as example the agriculture. We noticed that the world endure a strong exploitation of natural resources. In many countries, the situation related to the ecological system is characterized by a significant degradation which can reach, in certain case, an irreversible stage. By modeling the movement we can get more information about the animals' behavior, we can also predict their future movement. By this way, we can intervene to protect the environment by, for example, changing the direction of the displacement. Concerning the security, if we don't take the necessary precautions, there is a risk to lose a big number of animals, because of the roads. In fact, a lot of animals are killed each year because of the vehicle's speed. So, by modeling the displacement we can intervene in real time to alert the shepherd or to take it into consideration before the construction of a road to put enough alerts for the drivers. As mobile objects, we have a herd of animals. It can be composed by domestic animals (sheep, goats, camels, lambs, etc.) that follow a shepherd. In this case, the different information is going to be sent through wireless technology such as GPS. It can be composed also by wild animals (hors, pigs, gazelles, birds, etc.). They move without a supervisor. In this case, sensors are attached to individual animals. The signals are captured by satellites. In both case, we can get real-time information about each animal. The problem of the new technology is: it cannot give information that evaluates continuously, we

suppose then that the values of attributes are constant between two successive update. To store the different information, we used a Data Warehouse (DW). This choice is because of the expensive of the computation of the data bases rending online processing inapplicable. The traditional Data Warehouse (DW) and Spatial Data Warehouse (SDW) cannot deal with the spatiotemporal data this why we used a Trajectory Data Warehouse (TrDW) which takes into consideration the continuous evolution of the current position in function of the time. The data stored into TrDW allows anticipate the future movement of our herd by utilizing the linear interpolation. This last allows trace the trajectory. Despite, it is not quite the reality but it can serve as an approximation. The linear interpolation is very helpful, by starting from the present move; we study the animals' behavior and we can then predict the future one. In this paper, we focus on modeling the trajectory of the animals. It is a way to structure and organize the data to be understandable by the decision makers. In addition, it gives information about the trajectory as well as its components, so it serves to have ideas about the external factors that influence the path. We propose, then, on one hand, two ways to model the trajectory data, the first one is based on ER model and the second is based on Spaccapietra model. On the other hand, we propose TrDW model allowing the storage of the data into special DW. The purpose is facilitating the making decision in different domains. To achieve the goals fixed above, we propose to organize this paper as follow:

In section two, we present the different works existing in the literature and giving information about the problem of grazing, the moving objects and the evolution of DW. In section 3, we present the trajectory data which corresponds in our case to a spatio-temporal movement because we take into account the space XY and the time T. In section 4, we present two models allowing modeling the trajectory data. The first one is based on the Entity-Relation (ER) model and the second is based on the Spaccapietra model. In section 5, we present the TrDW as a way to store the collected Trajectory Data (TrD) and we propose the use of star schema.

II. RELATED WORK

The problem related to the degradation of vegetation becomes very important and crucial. Many works in the literature put the accent on this issue and as example [1] which addresses the problem of degradation in the steppes in Alger which causes the change of the ecosystem (from steppe to semi-desert).

This degradation is mainly due to the agricultural practices and livestock. Those latest are considered as the main responsible for the degradation of vegetation cover and accelerated erosion of soils that are noticed by agro-pastoralists. Among the proposed solutions, these practices have to be changed. Concerning [2], the authors addresse the case of pathways degradation in Tunisia and especially in El Hamma Gabes, while putting emphasis on the effect of overgrazing and purporting to be the principal causes of this phenomenon. Overgrazing is considered as the reduction of vegetation cover of perennial species and it results, according to [3], the loss of species which is the result of livestock and the initiation of erosion. This deterioration is exacerbated by the stocking density which is considered three times higher than the normal. The degradation and the overgrazing are increasing day by day especially in recent years which are characterized by their drought. And according to experts (ecologists and phyto-pastoralists) the problem of degradation and regression of rangelands is worsening (desertified areas would be 17% after 25 years and 49% in the case of intensification of current practices). According to [4], the authors present the problems encountered at the SIERRA MADRE OCCIDENTALE (northwestern Mexico). This area met strong exploitation of mountains which generated degradation by areal erosion and loss of pasture quality. A cause is the overgrazing, which has expanded at the expense of forests. In fact, in this area of livestock, breeding is regarded as the main activity and despite the declining population, the number of herds remains high which causes a worsening of the grazing pressure near the villages. In fact, to properly consider the condition of vegetation in a state, the authors in [5] require making several observations and obtaining data relating to crimes of overgrazing and according to studies, they concluded that overgrazing has an impact on vegetation either qualitative or quantitative scale. Indeed, qualitatively, good palatable species are eaten before they had time to train volunteer for future seasons and then they disappear completely, leaving room for non-palatable species such as Asphodelus microcarpus. To overcome the problem of the degradation of vegetation, it is important to study the animals' behavior to have enough information to be able to intervene, and as example of such study we propos [6].The authors focused on domestic animals and they deeply studied the different forms took by the animals during their movement, their rest or

their grazing. In the rest of this work, we will suppose that the animals move together (we do not care about those whose moves away from the herd). In this case, we consider them as points so their movement is studied as movement of points. About the speed and to facilitate the modeling thereafter, it corresponds to the speed of the animals of the front. We move then, to present the studies focusing on the moving objects. The authors in [7] give a description of moving objects through an abstraction. In fact, we can use a point or even a region to model a moving object and each model has its characteristics, for example, for a moving point, it corresponds to the change of position of an entity and this variation is done in function of the time and presented in 3D space as a curve. Related to a moving region, it focuses on the change of the size of a region. And the result of the presentation of a moving point in 3D space is polyline and for a region is a polyhedral. In order to present the movement, the authors use linear functions which give approximately finite descriptions but such functions are not enough to represent moving real, so, as solution they propose the use of quadratic polynomials. Concerning the work [8], it is interested on the repetitive nature of some moving objects. Such nature is detected through the follow of the moving object and storing the collected information into databases. Concerning the temporal aspect, it is presented through an instant and duration. The instant corresponds to a timestamp, and in a data base, it has a discrete representation. Concerning the duration, it describes a directed distance between two instant values. For an interval, it is described by its two end points, and they use a relative time intervals. In this work, the movement is divided into sever small slices having temporal function. So to present the whole movement, we must order the disjoint slices in function of the time The algorithm, which is presented in this paper and corresponds to repetitive movements, is composed by three steps:

- Creation of an array of integers from the flat representation of a moving object.
- Detection of repetition within the array of integer.
- Construction of a periodic moving object tree.

The purpose of this work [9] is to describe and discuss an approach to modeling moving and evolving spatial objects based on the use of abstract data types. This abstraction is presented by point region and line. It contains also a description of spatiotemporal types and operations. And to explain the conceptions,