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Towards a Collection-Based Knowledge Representation: the Example of Geopolitical Crisis Management

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1. Introduction

Although the term “Geopolitics” has been invented in the 20th century, geopolitical crisis management is an old research field. From antiquity, deciders know that their country’s geography has to be taken into consideration in political choices in order to protect the country from invasions (e.g. the Chinese great wall) or to guaranty the supply in natural resources. During those times the knowledge necessary to manage such geopolitical crisis was held by some specialists, working in the area for years and their expertise was lost in vain when they left that particular area.

In the 90’s with the evolution of IT tools and emergence of artificial intelligence, militaries began to think about using those new tools for improving geopolitical crisis management by doing a quasi real time geopolitical risk evaluation in order to forecast what events are willing to happen and how to avoid it. The Cheops project was one of those tools. It was a success but was limited by its object-based knowledge representation and so one, of its goals which was to be able to incorporate the knowledge of experts to help a military attaché to take decisions and discuss it in human language was impossible to reach.

In order to improve the system a new form of knowledge representation had to be found between the too formal object representation which is too limiting in terms of creativity and no representation. We propose a form of representation well known in the artistic domain: the collection which can be an attempt to represent knowledge in a very open form.

It also led us to rethink the role the system has to play: the decider needs a system to make him more creative and imaginative in terms of hypothesis and that should be the canvas for his reflection.

We will illustrate our studies trough the design of real crisis management systems.

The following sections are organized as follows: section 2 presents the classical approach of risk and crisis management through the design of Cheops, section 3 introduce the concept of collection as an alternative to object based knowledge representations; section 4 present how can collections contribute to redesigning our crisis management systems; section 5 presents the results obtained and addresses the future work and section 6 conclude on the

advantages of a collection based knowledge representation and its application in other domains.

2. Crisis management within classical knowledge representations: the Cheops project

2.1 The CHEOPS project

The CHEOPS Project was a geopolitical risk and crisis management system (Rousseaux, 1995). It was designed in 1997. Before the CHEOPS project, the knowledge necessary to manage such geo-political crisis was held by some specialists, working in the area for years and their expertise was lost in vain when they left that particular area. The CHEOPS project was a complete system aimed to use new tools offered by information technology like artificial intelligence, knowledge representation, geographical information systems (GIS) and databases to gather this knowledge and use it to help militaries to better understand the situation and to anticipate the events. This system also has to be multi user because crisis management is a typical a group activity.

The CHEOPS Project was based on a fictive crisis simulation in which a middle-east country (MEC) has some defence agreements with the French government. The French army has to defend MEC from any possible invasions from a foreign country but, at the same time, the French army must not take part in interior troubles resolution. So it is critical to determine if there are some threats against MEC; from where, who and what can be the consequences. In such an environment with lots of constraints from different types: geopolitical, economical, ethnical, etc... it is essential to act in the right manner at the right time.

In order to test the system in real conditions and to better understand needs and constraints, a scenario has been created as following: MEC is involved in a civil war where the rebels opposing the official government, are helped by a threatening neighbour country (TNC).

On the first day troubles appeared in some barracks, near the north frontier without having the possibility to know the causes of these troubles.

On the second day street Fights have been signalled in MEC capital near the national assembly, the consequence is that governmental troops have been sent from the north area to the capital.

On the third day, the airport of the capital has been bombed but the enemy fighter planes have not been identified. Experts are analysing bomb impact pictures. Rebels have old Soviet planes which would not have permitted them to commit this bombing.

2.2 Crisis management within an object-based knowledge representation

Before all it is essential to define what is a crisis. A crisis can be defined as a pool of events that, in a particular context will lead to some unwanted situation. In addition, we can define the crisis concept showing differences between permanent and crisis states. In the crisis state, the situation analysis is made harder because human discernment is wasted by stress, importance of stakes and indeed cost. The crisis generates a temporal paradox because its analysis and linked tasks, like communication or justification of choices, need time incompatible with crisis resolution. One man can not manage a whole crisis by himself like in the Marc Aurèle time. Only virtual or real human groups working together can face a dynamic and complex situation, and so it is a typical multi-participant activity. To meet this

multi participant requirement and match it with an IT based system, a multi-agent cooperation model has been realized.

In such multi-agent system, the challenge is to make human and artificial agents working together at the knowledge level (Newell, 1982). In addition, agents have to share the same knowledge which is on the basis of the crisis management.

To manage a situation with an "object" approach, the system matches any new event with a type event which has been identified from past events and crisis analysis and entered into the system. The same matching operation is done with situations: the system identifies the situation from all the events which happened in a given time and match it with a type situation. In order to predict the future situation, the system make analysis from past set of events entered in the system as ontologies and determines which one has the most probability to happen.

There are six main agents. The Military Attache (MA) collects information and sends argued reports on the situation (it is a human agent), the event database manager (EDM) classify each event, the map database manager (MDM) use a GIS to manage different maps, provides zoom and can put in relief thematic layers , the messenger (MSG) transmits messages (it is a human agent), the news report analyst (NRA) translates text news reports into the database format, the tactical simulator (TSIM) makes calculations and simulations in order to estimate current strength or necessary time to move units, and the arguer (ARGU) lets the user from tactical hypothesis to search corresponding events in the database and on the opposite, to analyse a pool of events in order to find strategic hypothesis.

Based on most of the activities on cooperation between human agents, we used the Maieutic approach (Plato, 1999) where the cooperation can be modelled with high level dialogues between agents.

Agents try to cooperate; they share a working memory where a history of their dialogues is recorded. In order to illustrate this model, we will use an artificial problem resolution dialogue between local crisis management computer agents.

The Table 1 presents an extract from the virtual dialog between agents. In this dialog we can see that the MA begins with an hypothesis: "interior troubles" because there are some hidden reasons that make him to prefer the hypothesis which does not need an intervention in order to avoid compromising. The arguer ARGU disagrees with MA hypothesis because he finds information that discredit MA event's classification. The MA is lead to test the ARGU hypothesis and ask him if he can show that rebels are implied in last events. ARGU does it and asks the tactical simulator (TSIM) to make a simulation of forces present in the north border area; the tactical simulator finds that the force ratio is highly in favour of the threatening neighbour country (TNC), ARGU reports to MA the situation.

The messenger (MSG) brings the confirmation that fighter planes which bombed the capital are a type of planes hold by TNC and so MA is lead to change his mind and to admit that passed events were not caused by some interior troubles but are evidence of an invasion in preparation.

This dialog is a part of a bigger one between all the agents managing all the events of the scenario.

A very interesting fact is that all this dialog between agents can fit into an inference's structure (Figure 1.) which is a well know graph in the social sciences domain (Simon & Lea, 1974; Michalski, 1986; Hoc, 1987) and can be easily be explored by IT tools.

1	MA: Did you receive the description of the events in the capital? It seems like the protestations are organized by some students from the opposition. This confirms that events in the barracks near the north border are probably just the consequence of a problem linked with the soldiers' salaries and so it is interior troubles...	Build-Event Classify-Event Test-Type-Event Select-Hypothesis
2	ARGU: I disagree, the cause of events in barracks is unknown because the M'Boutoul ethnic group implicated are with the rebels.	Classify-Event
3	MA: Can you show the possible role of rebels in recent events?	Test-Type-Event
4	ARGU: Yes! I can demonstrate it. (Demonstration following)	Classify-Event Test-Type-Event
5	MA: What are the consequences?	Generate-Strategic-Hypothesis
6	ARGU to TSIM: Can you make an estimation of forces present in the North area by taking the last events into consideration ?	Generate-Strategic-Hypothesis
7	TSIM to ARGU : Considering the rebel forces and TNC regiments the force ratio is unfavourable for MEC	Generate-Strategic-Hypothesis
8	ARGU to MA: If TNC rebels are implied, this means that an attack in the north area may happen at any time. The MEC defensive potential is low in this area	Generate-Strategic-Hypothesis
12	MSG intervention : I just received the news that we were waiting for : It is possible that fighter planes which have bombed the Capital Airport were from the Marchetti SF-260 type	Build-Event
13	MA to ARGU : You may be right	Select-Strategic-Candidate-Hypothesis
14	ARGU: Why this change of opinion ?	Select-Strategic-Candidate-Hypothesis
15	MA: Because the airport bombing has probably been committed by FTC who have this type of fighter planes, which means that a huge invasion may be in preparation	Build-Event Classify-Event Test Event Select-Strategic-Candidate-Hypothesis

Table 1. Extract from a dialog between agents in the problem resolution process.

Fig. 1. Inference’s structure.

The system is a success because it fulfilled its role: The human user is in permanent contradiction with an arguer agent who always tries to present other parts of the situation. The goal is to make the user sure of is decision and making him passing out non factual opinions based on hidden reasons. This is only possible if the arguer is replaced by a human. We could not manage with classical ontologies to make a virtual agent capable of questioning a human in his language (Turing, 1939; Turing, 1950) because it is a task which has to be realized at the knowledge level by an agent with high abstraction capabilities to figure out that a hypothesis is not reliable without testing all the possibilities. In addition, a computer, which use, logical relations to make hypothesis is limited in its hypothesis making process because all the situations are not logical. Given that this agent cannot be replaced by an artificial agent, the system has to be redesigned.

2.3 The perfect Arguer: between singularity and synthesis

We have seen that the way the system identify the events and synthesise them to hypothesis is essential. The identification of particular event can be called “singularity” identification as before any classification into the system each event is particular. The study of *singularity* and *synthesis* is essential to understand how to improve our decision helping software. We have seen in the Cheops example that the essential missing element of the arguer is the possibility to question the military Attaché on his decisions i.e.: find singularities in the arguments and justifications of an hypothesis. In terms of knowledge why humans are superior to the best computers? One of the possible explication is because humans know that they don’t know. We can experience this in everyday life. For example we were walking on Vancouver’s pier and looking at a motorized taxi boat which was sailing with a stream of water going from the hull. It came to our attention instantly leading us to discuss about the possible hypothesis on the function of this water stream. We wondered if it was an exit for water going into the boat or if it was a

water cooling system for the motor. As the streams of water were going out synchronized with motor noise it led us to the conclusion that it was a water cooling system. This reasoning based on successive singularity identification and syntheses is a good model of what could be an ideal arguer.

Why this singularity is automatically identified? Neuroscientists could explain this because the brain makes continuous assumptions on what will happen on the next milliseconds. If something is unknown we cannot make assumption on it and it is viewed as a "potential threat". This process of identifying singularities salience is multi-dimensional: semantic, logic, spatiotemporal, emotional, etc.... As even for humans the exact cognitive process of salience is unknown it cannot be implemented in computers.

In an object based knowledge representation, if we present a new object to the computer it will compare it to the pool of type-object he knows from different classes on a certain base : lexical, logical etc... and classify the object based on this chosen parameter. The characteristics of the object which as not be chosen as principal will remains as particular properties of the object but this process of casting into a type make (that we could also call syntheses) transforms this object.

And so it is interesting to think about the counterpart of the singularity: the syntheses.

Singularity and synthesis share the facts that when we think about them, it lead to their spontaneous conversion. Thinking affects their nature by desingularization and immediate analysis. It can be compared in physics with quantum mechanics where it is impossible to know speed and position of a photon in the same time and without modifying it.

Synthesis come from Greek "sunthesis" = be together. But there is a multitude of forms of "being together" which co-exist. We can quote as examples: nature of the synthesized, its individualization mode, its causes, its origins or genesis, its future or horizon, its goals and modalities its structure and form, its organization and its composition, its operation, its exchanges and/or interactions with its environment, modalities of being together (in the time, the place or duration), its raison or utility its explication or justification...

As we can see, there is as many ways of being together that modes of not being together. Multiplicity of modes of being together is so huge that we are happy when we can justify the existence of one of them with a concordance of different species. Sometimes it is syntheses which are based and conjugate different modes of intellections. More often it is syntheses based on a mode of perception and a mode of intellection.

For the first type examples we can quote Cladistic which orders living organisms in phylogenies from species evolution before any "kind casting" based on aspectual similarities. For example based only on characteristics without any aspectual similarities we can compare monkeys, horses and lizard: they have 2 eyes, a tail but horses do not have 5 differentiated fingers on the anterior leg. This mode of classification is commonly used by actual biologist and it brings new point of view on aspectual similarities which only come with the filter of phylogenic bifurcations.

There are many second type examples: Computer simulations of plant growth are one of them. It interests researcher in sciences of complexity because in the same time it shows the shape and the ontogenesis of a given plant. For them such a simulation is better than a hand made drawing because they can be interpreted in terms of formal realism but also in terms of genetic plant simulation in his cycle of life. It is the same for the shell or the broccoli since we know fractal equations because their beauty can be seen in the same time by the perception and by a certain mathematical intellection.

We can find very convenient to put together different modes of justification for a same declared synthesis. But it also happens that we can take advantages from concurrent justifications. It is usual to find the simultaneous presence of the couple singularity-synthesis. This couple is it inseparable or does it constitute itself spontaneously when we see a synthesis which becomes analytic? How can what we experience can be converted in knowledge that we will know and that we will think we can use it when we want. ? How can singular immediate experiences contribute to build categories that we will use in future interpretative tasks? How to generalize singularities? The subject seems to be absurd because only particulars can be generalized: they cannot do anything more when they are frozen in a synthesis. Even the only one in its kind is not singular when it is ordered. Singularity and synthesis share the fact that they can be seen as disappearance for the first one when it become analytic and for the second one when it become particular. What can be the link between singularity and synthesis ? However a place exists for thinking together singularity and synthesis, this place is **the Collection**.

3. Collections as a new paradigm in our knowledge representation

From here, we will call *collection* this specific figure, which the present paragraph means to study. We will show that: This acceptation of the word collection is close to its usual meaning; That a collection differs from the notions of ensemble, class, series, set, group, or clutter but also from that of organic whole or family; That a collection is the institution of a metastable equilibrium between singularity and category, just as other concurrent fictions such as fashion, crises, choreographies, plans, liturgical cycles, scientific projects, or instrumental gestures.

3.1 The notion of collection

To begin better understand the concept of collection we can quote Gérard Wajcman's analyses (Criqui & Wajcman, 2004) on the status of excess in collections: "Excess in collections does not mean disordered accumulation; it is a constitutive principle: for a collection to exist—in the eyes of the collector himself—the number of works has to be greater than the number than can be presented and stored at the collector's home. Therefore someone who lives in a studio can very well have a collection: he only needs to have one piece that cannot be hanged in his studio. That is why the reserves are an integral part of a collection. Excess can also be noted at the level of the memorizing capacities: for a collection to exist, the collector just needs to be unable to remember all the artworks he possesses. The collector should not completely be the master of his collection".

A collection is far from a simple juxtaposition or reunion of individual elements. It is primarily a temporary correlate of an initiatory ritual made sacred by time. Adding works, or revisiting a collection keeps altering and re-constituting it, leaving it always halfway between the original series of juxtaposed intimate moments and a permanently organized class of objects. Unlike an organic whole, a collection only exists for each of its parts, and unlike an ensemble, it does not exist as a normative or equalizing unity; it is productive if in tension between singularities and categorical structure.

As Gerard Wajcman writes, thinking probably of Gertrude Stein (Wajcman, 1999), " If nobody ever looks at "a collection," it is because it is not a collection of artworks, but an indefinite series of singular objects, an artwork + another artwork + another artwork..."

For the artist, the collection of his own works is like (In *The pastoral symphony* by André Gide) Matthew's herd: "Every painting on the easel, taken separately, is more precious to the painter than the rest of his collection". But in that case, the election of the next painting to be presented is naturally prescribed par the exhibit/procession. Series are never set a priori, and a specific painting never make us forget the rest of the collection.

The collector, at this point, is interested about what his collection lacks, about its virtual development. It is through the repetition of intimate lived moments that a collection is created. By this gesture is instituted not only the same, which unifies the collection through the similarities supposedly going through the collected objects, but also the object nature of the specific things that constitute the collection.

Collecting is therefore part of an initiatory journey, between what was lived and what can be communicated, and thus becomes a sacred activity, just as creating. The process of reconstitution regenerates the coherence of the collection. If the reconstitution is not well done, the collection can soon be abandoned, or dispersed. A collection ceases to exist as something else than a mundane correlate as soon as the collector ceases to be interested in its development. Then he stops repeating the acquiring gesture or the reconstituting gesture for himself or his intimate friends.

These two gestures have the same meaning. The reconstitution gives better balance to the heavy tendencies of the collection, makes new relationships appear between artworks, and institutes new similarities which later influence the logic of acquisition. New objects become part of the collection as "different," and they become "same" only later, because they have in common to be different, thus being part of what Jean-Claude Milner calls a paradoxical class. It is rather easy to spot individual cases of collections that were abandoned.

The synthetic nature of an ensemble of objects presented to be seen as a collection is different from the nature of the ensemble that is constituted and shown by the collector. Indeed, the collector does not juxtapose objects; he puts together elements of remembrance, to be prompted by objects. Walter Benjamin, quoted by Jean-Pierre Criqui (Benjamin, 1989) writes: "Everything that is present to memory, to thought, to consciousness becomes a base, a frame, a pedestal, a casket for the object possessed. The art of collecting is a form of practical recollection, and, of all the profane manifestations of proximity, it is the most convincing."

3.2 Collections and Knowledge management in IT

Collections as an alternative to formal ontologies appear as a metastable equilibrium coming from a productive tension between categorical structures and singularities. If in everyday life, collection can be distinguished from list, ensemble, class, series, set, group or clutter but also from that of organic whole or family, from lineage, cohort or procession it is by the mode where it donated.

The donation of the collection (to the visitor or to the collector, if it is in acquiring or recollection) appears under the paradox that a donation as a whole coherent is impossible excepted in the reducing mode of collection management. Because in this mode even a clutter can be seen as a coherent whole because all the objects have in common to be different forming what Jean-Claude Milner calls a paradoxal class.

In other words we can see the collection as a coherent whole but only if we renounce to one of its properties: the impossibility to experience anything else that the sheep apart from the herd, always more precious than the rest of the flock together.

What are the consequences of those considerations in the applicative domain of information systems and of decision helping and content-based browsing software?

Collection manifests a mode of synthesis characterized by a possibility to be reconstructed from only one look of the shepherd (collector or visitor) on one of its constituting part. This characteristic clearly distinguish collection from class, or from category where the observation of one prototype or one example is incapable of specifying alone a reconstitution

So *collections* can be defined as IT objects; considered as lists or ensembles grouping objects in synthetic position of “being together” – ---(onto-chrono)logical, synoptic and other- inside the IT environment for a given level. Those same objects are considered at any time as being susceptible of reconstitution on another level of the IT environment.

This schizophrenia of the environment is a characteristic of IT tools for collection management or for helping content-based browsing. It benefits to the user, powerful artisan of singular recollections that he do constantly.

3.3 Figural Collections as a new form of knowledge representation

For Piaget (Piaget & Inhelder, 1980), the main difference between collections and classes is that a collection exists only because of the union of its elements in space whereas elements of a class can be separated in space without changing class properties. For example: cats have in common certain properties whereas other properties are common with other animals but in this definition of a class there is no property or relation linked with space: cats can be dispersed in space randomly or in groups, it will not modify the class properties. On the opposite, a collection like a collection of paintings is a whole: a painting cannot be removed from the collection without modifying the collection itself. We can also distinguish figural collections and non-figural collection. A figural collection is a figure itself, not mandatory linked with relations between its elements. In this project we will focus on these figural collections which are the only ones which can represent spatio-temporal dependence needed in the crisis management.

As a model of a figural collection we studied what can be the analogies between a collection of paintings in a museum and a collection of geopolitical events. In a museum the main agent is the curator; his role is to manage the collection. The subject of the collection has been previously defined (e.g.: impressionist paintings) and he has to buy new paintings to keep the collection up to date, to arrange and rearrange spatially the collection in the way it is displayed to the public (with the help of other agents who put the paintings in place), he can also conduct research on archives of the collection (with archivist agents) and rearrange the collection between the displayed collection and the collection’s archives or reserves (with reservist agents). As we have seen before, a collection is a whole and the collection’s archives or reserves of the collection have the same importance as the displayed part. The following table shows possible analogies between museum’s curator and collection’s curator in a geo-political risk and crisis management system.

	Museum	Geo-political crisis management
1	Manage the collection of Paintings	Manage the collection of Events
2	Buy or sell paintings to keep collection up to date	Integrate new events in the collection
3	Arrange and rearrange spatially the collection for public (humans)	Arrange and rearrange spatially events in the system interface for public (human and artificial agents)
4	Conduct research on archives (with archivists) to find new information on paintings	Conduct research on archives(with archivists) to find new links between events and situations or new information
5	rearrange the collection between the displayed collection and the collection's archives or reserves to refresh the collection	rearrange the collection between the displayed collection and the collection's archives or reserves to bring creativity by showing new embryos of hypothesis

Table 2. Analogies between curator’s role in a museum and in a geo-political crisis management system

Every museum has a displayed part of the collection and a part of the collection in the reserves. The coherence of the collection is guaranteed by the collector or the curator. The way the collection is displayed is crucial because it is more than paintings put together. Each painting has its meaning for the collection just displayed with others. When displayed in a certain way the paintings tell a story and bring some feelings; displayed in another way they will also tell another story and bring other feelings. It will be the same for the geo-political crisis: displayed in a certain way events will tell a certain story and bring hypothesis of what will happen. The user interacts with the collection to arrange and rearrange it accordingly.

4. Use of collections for redesigning our critical decision helping systems

Within the new knowledge representation the system can play a new role: it can be seen as a creativity helper. We renounced to build an arguer making hypothesis at the knowledge level. We decided to build a system which suggests embryos of hypothesis in displaying events and information in different ways, helping user’s creativity. As we have seen before a computer can not be creative as humans in terms of hypothesis and maieutic questioning but it can be better than humans for calculations (e.g. : path length, time to area etc...), data fusion/aggregation. We choose to use this repartition for studying how collections can improve our critical decision making. We called our new system iCheops (iCheops, 2008) because we are using the “Web 2.0 revolution” and its new tools (API’s Application Programming Interface) that let developers to bring easily new functionalities that where very complicated to implement few years before. We can quote as example the implementation of the GIS (Geographical Information System) which on the original Cheops project required more than 70% of the total resources of the project (High definition satellite maps of each zone add to be purchased individually,

digitalized and objects add to be manually encoded into the GIS format) and that now can be easily replaced by the Google Maps API (Google Map API, 2009).

4.1 Architecture of the system

Fig. 2. General Architecture of the system

The architecture is a typical web application architecture where many users can access the system without any previous installation. The system is also interoperable and can be accessed by any machine (computer, PDA, Smartphone) which has a web browser. The iCheops system is installed on a web server and so can access autonomously to many data sources (e.g.: Google maps, news databases, governmental websites, etc...). The two demonstrators we will present later in this section are developed in AJAX (Asynchronous Javascript And XML). The main interest of this technology is to bring desktop like functionalities to the web sites. In terms of HCI (Human Computer Interface), Ajax brings more flexibility and interactivity. All the elements of a classical desktop interface (sliders, splash screens, dropping menus, etc...) can be implemented. Ajax also let developers to design new types of application, closing the gap between the desktop and the web.

The iCheops community of agents is the following:

The Military Attaché (MA) (is a human agent) is the curator of the collection: he chooses which events he wants to put in his collection and on which he wants to conduct analyses. He has also the role of configuring the behavior of software agents; more than one Military Attaché can modify the same collection. The News Crawler (NC) is always running in background and feeds the event database with news retrieved from different news databases (e.g. : Reuters, AFP, le monde, the New York Times, etc...). The archivist agent (ARCH)

conduct research on past crisis: it can correlate specified events with past events and show it to the military Attaché who can decide to put them also on the map. A Fusion/Aggregation agent (F/A) can help the military attaché to conduct analysis on a collection of event; this agent can also crawl the web to search for links between objects. A text translator (TT) can be mobilized by every agent in order to translate data into military Attaché's language. A time manager (CHRONOS) can replay cognitive process of past crisis. The Map Overlay Manager (MOM) displays the part of the map needed by the user. Normally this process is automatic through the Google Map API but in certain cases if the user wants a custom map overlay the MOM agent will overlay it accordingly. MOM has also in charge to overlay different types of information custom information coming from the user (icons, comments etc..) but it can also propose the different overlays available for the concerned area according to the data available in his database (e.g.: power grid, density of population etc...). If MOM does not have the information needed the user can ask a Map crawler (MC) to propose him different sets of data to incorporate to the map or to help him to find data sources. The tactical simulator (TSIM) makes calculations and simulations in order to estimate current strength or necessary time to move units.

Fig. 3. iCheops Agent simplified cooperation model

There is two main modes in iCheops: The curator mode for the military attaché and the visitor mode. The curator can do everything and can plan a visit spatiotemporal visit for a

visitor. The visitor can visualize the visit proposed by the curator but can do also his own visit in the collection of events and can put annotations for the curator. Like in a museum there is also a physical distinction between the displayed collection and the reserves: the two sets of events are in two different databases.

We build two demonstrators each one implementing a part of the iCheops system:

A first one Geonews is dealing with databases, data fusion/aggregation, time management, crisis anticipation and we choose to use it for research about crisis management at the knowledge level.

A second one Netsensor deals more specifically with Human Computer Interface and visualization. A client who sells sensor networks for Unattended Ground Sensors (UGS) needed to demonstrate capabilities of its systems. We choose to use this opportunity to build the MOM (Map Overlay Manager) and the TSIM (Tactical Simulator) agents for iCHEOPS.

4.2 The Geonews demonstrator

In crisis management, information spatialization, evaluation, as well as data fusion/aggregation, time management, resources mobilization, real time analysis is a proactive analysis. In order to be able to demonstrate those features we choose to make a system that displays spatially news from internet websites to manage this collection of news and to do some analysis on it.

The objective is to show the events in time and space and to do some basic processing in order to find similar events in an area and to find if there is a possible threat in this area.

Fig. 4. Screenshot of the Geonews demonstrator

A database contains a huge collection of events. Because it is for a proof of concept, the event descriptions have been extracted from free online newspapers. Each event has been tagged with a geographic position (latitude, longitude), a date and a time. The user can select spatially or temporally the events to display. Each user (military attaché) can create its own collection of events. The user can also add manually an event into the database. Basic operations can be done on the user’s collection: add an event, remove an event, visualize the event on the map and select some event to do data fusion.)

Fig. 5. The Geonews simplified agent cooperation model

Figure 5 presents an simplified agent cooperation model. Only the most important interactions have been represented. A News Crawler crawl the web adding new events into the reserves database. NC can be configured by the military attaché (MA) through the config.html file (e.g. : topics, languages, keywords, data sources to include). All the agents can be configured in the same way. When the military attaché navigates temporarily through events the CHRONOS agent is called (green arrow on Figure 5) CHRONOS will interact with the Map Overlay Manager to display spatially and temporarily the events contained in the reserves. MA can choose to add an event in his collection through the archivist agent (ARCH).

The data fusion made by the Fusion / Aggregation agent (F/ A) on the collection of events is quite simple: a list of “irrelevant” words has been made according to the language of the database, which is French for this project. This list contains, determinants, pronouns, connectors and auxiliary verbs. Then a loop counts the number of occurrences of each word

and the words are displayed as a tag cloud (figure 6) where the words with the most occurrences are displayed in a bigger font.

Fig. 6. Tag cloud of the Cheops scenario

4.3 The Netsensor demonstrator

The market of UGS (Unattended Ground Sensors) is very competitive and in order to make the difference with competitors, it is important to be very innovative. Before the Netsensor project, the client used to present his products to military agencies on a map background but it was not interactive at all. For each presentation he had to do screenshots and overlay sample pictures of the products.

We developed an online application where he can simulate the behavior of the UGS systems and interact with them. For example we can choose the geographical place, the number and the type of sensors to put their range, the attenuation of radio range and detection range induced by the terrain topography. Then we can simulate the trajectory of enemies and see how each sensor detect the enemy.

Fig. 7. Screenshot of the Netsensor demonstrator

The system is decomposed in 2 modes: one for editing scenarios and one for running in commercial demonstrations still on the model of museum with the making of the collection and its visit.

The tactical simulator (TSIM) is capable of doing calculation in real time on the time to move units, the estimated distance from the enemies to the base, the time before possible attack etc. Data concerning enemy speed is store in a database of enemies' possible properties. With the help of the Map Overlay Manager (MOM) the user can place an enemy icon and trace its trajectory and he will see the enemy moving according to its speed.

Technically a table in the database contains the general properties of the application (e.g.: password, scenarios, users, default parameters for each sensors) and each scenario is associated with a table of the database containing all the properties of the particular scenario (e.g.: number of sensors, enemies, trajectories of the enemy, enemy speed). When the user runs the scenario, a timer is started in order to refresh the page at fixed interval of time, for showing enemy progression in live. MOM let also the user overlay different layers of information (radio range, detection range, assets etc...) that he can choose to display or hide at any time. If an enemy crosses a detection area of a sensor an alert is sent as a form of a popup.

5. Results and perspective of evolution

As the iCheops is not finished yet we can not make real studies of performances on real examples of crisis management but we can evaluate the utility and creativity of the two demonstrators we developed.

Geonews appeared to be a very interesting tool because when we use it we can see instantly the potential that have spatiotemporal representation and also representation of knowledge in collections.

When we read a newspaper we can forget very easily events and also it is very difficult to link different event in a context. Newspapers are mostly organized in an object-like form : in categories (business, world, technology, etc....) and it is hard to cross those categories to understand something in its whole context as well as it is hard to cross correlates information from different newspapers.

Our demonstrator let the user browse all the events on a certain area of the world and he can see how different data sources speak about this zone. It is essential in order to understand easily the geopolitics of a certain area. The Text Translator agent which will be developed in a next version will be useful for completing the achievement of this goal.

In addition nowadays with globalization an event can have consequences globally and it is also interesting to be able to see what can be the perimeter of consequences of an event. With the fusion/aggregation agent of Geonews we can put in relief some words related to some concepts and it is designed to encourage the user to continue his search by giving him new path to explore. As an example we used the F/A agent with the food crisis in Haiti and the tag cloud linked this event to the FMI and to other food crisis happening in the world. The principle of organizing relevant events in a collection appears to be very interesting because this collection is not a replacement of our memory but it is an active canvas for our cognition. As a parallel we can quote the organization of human memory: it is usual to think that we forgot something and like Proust's madeleine by the taste it lead us to a remembrance of a past event associated with this Madeleine. This madeleine is the element

of remembrance but this Madeleine is significant only for the one who experienced the situation and is not always understandable. It is a good justification of why our collection knowledge representation can be a canvas for those elements of remembrance.

For its evolution we will improve data fusion and aggregation. But we would like to avoid as much as possible classical “knowledge gathering” tools using linguistics. Linguistic and natural language processing can be useful in some case to represent knowledge but we would like to use it as metadata and not as the main knowledge gathering technique.

We would like to try some simple techniques that have been applied in the domain of arts (Pachet & Cazaly, 2000) to search some similarities in an event collection and then to sort events in heaps in function of the principal component. We also would like to work on 3D representations of the collection of events in order to see if it can improve the “feeling of knowledge” and the understanding of the whole situation.

Netsensor is an industrial success because it gives a competitive advantage to our client. In the same time it helped us better understand constraints and capabilities of web based tactical simulator. The possibilities are huge because we can find a large amount of useful data on the web that we can overlay through the Google Map API. It demonstrates also the power of web based tool because, compared to the original Cheops project where more that 70% of resources was used for the GIS, here we could focus on principal aspects(user interface, databases, crisis management,...) of the project by using no resources for the GIS itself. Some limitations appeared also during the development we can quote for example the interactions between agents which are more complicated to organize than in classical desktop software. Some agents are scripts running in background of the server and other ones are scripts executed when the user load a page. With the uncertain network transfer time it is also difficult to do some real time synchronizing. It raises also the concerns of data security which are important in geopolitics. We need to find a good compromise between security of data and time to decrypt it. This algorithm should be adaptive in function of sensitivity of data: if some data are not critical we should be able to send it with a minimum encryption which increases the speed of the system.

In terms of evolution next versions will use the Google Earth API which is now in 3D and what will improve the simulation by adding another dimension which is critical. This big step will be a real challenge because 3D simulations are much more difficult to implement.

For the general iCheops project, the next step will be to integrate the two demonstrator in iCheops and trying to find new models to organize the community of agents and their interactions. As the concept of collection is a form of emergence we will study if we can apply some results coming from the field of ecology (Van Peach, 2002) or system biology which study emergence of organization in populations (e.g. :bacteria).

We will also work on the concept 3D collections in order to see in which extent the third dimension can improve knowledge representations.

6. Conclusion

In this chapter we demonstrated that the concept of collection can be used as a knowledge representation and its implementation in IT can improve tools that were very difficult to implement in object-based knowledge representation. It appeared to be a good alternative to classical object-based knowledge representation.

This collection-based knowledge representation can be used in many domains where a object-type matching loses a part of the object. We can find many examples in different domains: In digital data management it can be more relevant to manage a whole collection of files than to match it with their type. For example, it is too limiting to match a song with a music style and it limits the choice of the listener (Pachet & Cazaly, 2000).

A lot still has to be done but the matter is scientifically rich enough to let a great deal of researchers in multidisciplinary domains to bring their contribution. This subject is a challenge for us because beyond technological and scientific aspects invites us to think about our intelligence and the way we are representing the world.

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This book is a compilation of writings handpicked in esteemed scientific conferences that present the variety of ways to approach this multifaceted phenomenon. In this book, knowledge management is seen as an integral part of information and communications technology (ICT). The topic is first approached from the more general perspective, starting with discussing knowledge management's role as a medium towards increasing productivity in organizations. In the starting chapters of the book, the duality between technology and humans is also taken into account. In the following chapters, one may see the essence and multifaceted nature of knowledge management through branch-specific observations and studies. Towards the end of the book the ontological side of knowledge management is illuminated. The book ends with two special applications of knowledge management.

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