A Multi-Agent Expert System for Child Abuse Prevention

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Abstract - When a child abuse situation arises, the responsible agencies and entities in charge of response should be capable of providing a fast and personalized solution for the good of the child. This need leads us to consider the formation of dynamic virtual organizations tailored to each particular abuse case. In our approach the partner selection of these collaborative networks is done through a software tool that combines two technologies from the field of artificial intelligence, specifically multi-agent systems and expert systems. In addition, these partners come from the breeding environment constituted by all the agencies or individuals, either in a region or locality, which have the potential of response.

Keywords: Multi-Agent Systems, Expert Systems, Child Abuse Prevention, Dynamic Virtual Organizations, VO Breeding Environments

1 Introduction

Child abuse is a universal phenomenon that we must strive to eradicate from our society. This goal, undoubtedly ambitious, requires an intensive work in the education of every individual and, of course, in the recognition of the children’s rights.

Although in recent years significant progress has been made in this sense, our efforts must continue as long as abused children exist. We have the responsibility to protect them, using the different resources available. In this sense, we have to search for new solutions and tools that allow us responding promptly and in a personalized way.

To provide this response is necessary to promote a networking model that involves all stakeholders (both entities and people) in the prevention and the solution of child abuse. Every stakeholder must contribute to the collaboration by providing its core business.

However, this network collaboration must face several challenges to become a truly effective instrument to combat the problem of child abuse. Pablo Herrero [1] identifies some of these problems: excessive specialization of the social services, urgency in the response, the pressure, lack of diagnosis, pseudo-agreements, the triangulations and the competition between services, etc.

On the other hand, every case is unique (it is not the same to deal with a sexual abuse case than a peer victimization intervention), so that networks must involve different components in each new situation, and even these components can vary during the performance. It is necessary, therefore, a dynamic and flexible network that allows the continuing evolution of resources and services, as well as the incorporation of new ones.

These inter-collaborative problems in child abuse domain are difficult to solve without considering the new organizational models and the Information and Communication Technologies (ICT). The ICTs are a key element in order to promote efficient and innovative networking solutions designed to prevent child abuse in all its variants.

In this sense, our work is focused on the creation of Dynamic Virtual Organizations (DVO) that meet the demands of each abuse situation. The selection of the members is done through a multi-agent expert software tool. It is an approach that solves, or at least reduces, most of these difficulties in a simple and intuitive way.

We also consider that any initiative in this area has to bear in mind the Virtual Organization Breeding Environments (VBE) concept. In child abuse domain these long-term networks are going to be constituted by entities from the different fields (both educational, social, police, judicial and health) involved in Child Abuse Prevention (CAP) in their secondary and tertiary levels.

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The use of software agents whose behavior is guided by an expert system is a novelty and an innovation in the field of networking methodology aimed at preventing child abuse. This combination allows optimizing the use of resources and simplifying communication between institutions and professionals, which makes possible a more agile response of the DVO created ad hoc abuse problem.

With our work we try to ensure that networking is not going to be reduced to a simple coordination of institutions as if they were watertight compartment. We, ultimately, are trying to get the best answers to those questions always present in a case of child abuse.

In conclusion, it might be mentioned that the networking concept becomes tangible and acquire a dynamic nature according to the needs and requirements of individual cases of abuse.

2 Child abuse

The United Nations Convention on the Rights of the Child 1989 defines child abuse as "all forms of physical or mental violence, injury or abuse, neglect or negligent treatment, maltreatment or exploitation, including sexual abuse, while in the care of parent(s), legal guardian(s) or any other person who has the care of the child." In short, we can say that there is child abuse if children's rights are not respected and there is not a response to their needs [3]; we cannot forget that abuse is, primarily, the lack of good treatment.

But the lack of good treatment can take several forms (physical, sexual, psychological, neglect, etc.), which come in a great variety of types depending on the situation, the involved actors, the degree of intensity, and so on. Each abuse situation is unique and requires, of course, a different approach; it is necessary to define and design an appropriate response to each particular case. In this sense, prevention is the best possible approximation to the problem of child abuse.

Prevention may take place at three different levels: primary, secondary and tertiary.

- **Primary prevention** aims to decrease the incidence or onset of abuse cases, through child advocacy and special attention to their needs. It applies to the general population, in order to the community becomes aware about the problem and acquires positive habits and behaviors that prevent the appearance of the child abuse.

- **Secondary prevention** focuses, for its part, on the concept of risk. This prevention is addressed to social groups, families or individuals classified as "high risk" to avoid certain situations that end up in abuse.

- **Finally, tertiary prevention** tries to reduce the duration and severity of the consequences of the problem (stage of rehabilitation or cure). It also requires the intervention in the context, family, etc., to prevent its recurrence.

As we shall see below, our work can be perfectly included in the latter two levels of prevention, and especially in the tertiary one.

2.1 Networking in the child abuse domain

Networking is the way of achieving a collaborative workspace where to achieve the pursued goals. It is based on the communication of the agents and institutions, among which there must be an optimum exchange of information, both qualitative and quantitative.

The originators of the sociotherapeutic networking were Speck and Attneave [4]. They created therapeutic teams for intervening in families in crisis, in the United States, in order to break destructive patterns of family relationships and provide support for alternative options. Several years later, in the eighties, Elkaim [5] carried out the first practice at European level in deprived areas of Belgium. Since then, the networking experiences have evolved and multiplied.

In our country, Spain, we find the networking pilot program of Burlada (Pamplona). Its promoters recognize that one of the challenges of any network program is to provide a process of organizing the different institutional levels and professional resources, in order to ensure the creativity and competence of each one of these instances [6].

These and other works, experiences and projects emphasize the need of networking as a mean to achieve the ultimate goal of prevention and resolution of child abuse, establishing guidelines and procedures that normally are constructed ad hoc to the context in which they are developing. They do not possess, in addition, software tools capable of solving the different problems of such kind of relationships, among which the need for a rapid intervention highlights.

Our job serves, precisely, to overcome this deficiency. We pursue the interconnection, in a quick and efficient way, of those professionals and institutions that must be part of the answer. Starting from a simple notification in the system, a dynamic virtual organization is configured in order to respond to the specific abuse case in a personalized way and with little human intervention.
The basis of our work

There are several similarities between networking that a child abuse situation requires and the networking of the dynamic virtual organization. Below, we will summarize the more interesting ideas to understand our work, although previously it is necessary to describe the Dynamic Virtual Organization and VO Breeding Environments concepts.

3.1 The DVO in the VBE context

The Dynamic Virtual Organizations are rapid creation and fast dissolution organizations [7], constructed ad hoc to the opportunity of collaboration. In a DVO a set of business partners come together dynamically, on demand, and in accordance with the requirements and needs [8] of the problem, disappearing when the needs have been met.

However, the creation of a DVO whenever a new collaboration opportunity emerges requires large amounts of time and resources, reducing the agility associated with this business model. The effectiveness of the process depends largely on the availability of adequate information about potential partners, their level of preparedness to engage in a DVO, the existence of trust, etc.

To solve some of these problems, different authors have begun to consider that the formation of such organizations has to take place in the context of what Afsarmanesh and Camarinha-Matos [9] have called Virtual Organization Breeding Environments. The VBEs are clubs of organizations prepared to work in long term relations and from which temporary coalitions emerge able to respond dynamically to the different business opportunities [10].

The VBE simplifies the configuration and establishment of DVOs since it solves, or reduces, many of the obstacles associated with the temporality of such organizations, contributing, thus, to their creation in a more efficient way. Partners of the DVO can, this way, benefit from unexpected changes in their context, providing an agile response to the problems or the opportunities.

3.2 Equivalence between DVO and networking in child abuse domain

We can start, for example, talking about the VO breeding environments. In the case of child abuse domain it is obvious that the VBE would be constituted by any entity or person involved in the solution: schools, social services, health centers, youth services, law enforcement agencies, state security bodies, and so on.

Every one of them brings to the partnership its core business, what they do best, so the VBE contains all necessary processes that the abuse situation requires. In addition, these entities are required to share certain culture of work (action protocols...), ICT infrastructure, etc., to achieve the highest possible performance.

After identifying a new case of abuse (either in the school, or in a health center, or through a complaint at the police station or in the child line, etc.) it is time to use the breeding environment and select the set of institutions and/or persons that are the best prepared to respond to this particular problem.

The union of the different entities that have been selected configures, ultimately, the dynamic virtual organization responsible for providing the personalized answer to the initial child abuse situation. Naturally, different virtual organizations can arise from the breeding environment to provide this response, although the selection of the best one depends on the requirements and needs of the particular situation of abuse and on the features and capacities of the partners.

After the selection of the components of the DVO, partners need to coordinate their actions, they have to work together in order to find an efficient and agile solution to the problem: in other words, operation phase starts. This phase lasts until an adequate response to initial problem has been achieved. This moment coincides, precisely, with the dissolution phase of the dynamic VO.

On the other hand, we must also notice that the entities of a particular DVO can be partners of another consortium which tries to response to a different abuse case. In addition, whenever it is necessary in the DVO performance, more partners can be searched, or even their number can be reduced, and so on, according to the changes of each abuse case. In short, during the operational of the DVO a reconfiguration phase can take place.

4 The VCAP multi-agent expert platform

Our fundamental objective is to enhance and develop a networking model through the creation of DVOs that are capable of facing the child abuse problems in an agile and efficient way. It is therefore necessary to align the concepts of VBE and DVO to the child abuse domain and provide tools that facilitate both its formation as its operational.

In order to provide an efficient solution to the formation problem, this paper proposes an approach based on the Multi-Agent System (MAS) paradigm. This technology provides several advantages over other methods previously proposed, especially for its ability to manage complex and distributed problems. But in addition, agents in our MAS have an intelligent behavior through a rule-based Expert
System (ES) implemented in their decision module. Finally, the identification of intelligent agents is made through an innovative model based on the VBE concept.

With this new approach the best combination of partners is defined dynamically in real time based on system state, the features of the problem and the predefined objectives of the stakeholders. The identification and assignment of these stakeholders to the child abuse problems emerges from the interaction between the agents, through different negotiation mechanisms. In this sense, we can introduce the Virtual Child Abuse Prevention (VCAP) concept.

4.1 MAS and ES

In the multi-agent systems the core element is the software agent, a computer entity with some defined targets and able to act flexibly in its environment. These agents are typically autonomous, reactive, pro-active and have social skills, that allow them to interact with each other and their environment by exchanging messages [11].

The characteristic of sociability makes agents a very interesting concept to develop distributed systems where several agents interact each other and with the environment to create multi-agent systems. Each of these agents has the ability to solve a specific part of the problem, so that together they can achieve the desired functionality and operate asynchronously without a central control system.

Moreover, to give an effective response, software agents should behave, think and act like a human expert in the domain would do, but how can we do this? For this purpose we have considered the expert systems. By definition, an expert system is a computer program that simulates the thought process (learning, memorization, reasoning, communication, etc.) of a human expert to solve complex decision problems in a specific domain. By this way, ES can [12] store data and knowledge, draw logical conclusions, make decisions, communicate with human experts, explain their decisions, etc., and, as a consequence of all above, take actions.

Thanks to these systems, and in particular to a rule-based ES, we obtain agents with a rational behavior based on the knowledge and expertise of human experts in the child abuse area. Thus, without resorting to complex mathematical procedures, the agents are able to make the best decisions based on the needs of the problem and on the structured knowledge that has been supplied to them.

The introduction of the expert system is a clear innovation, from the technological point of view, over other existing multi-agent solutions.

4.2 DVEBreeder platform

In the University of Valladolid, we have developed the DVEBreeder multi-agent expert platform, which uses the VBE concept to build DVEs [13, 14] effectively. In this platform the identification of intelligent agents is made through an innovative model [15] and within the VBE context. After identifying the agents capable of performing the required tasks, these negotiate with one another based on the knowledge embodied in its decision modules, resulting in the formation of a DVE.

This platform has been built with various interesting features, such as modularity and flexibility. Thanks to this, we can easily adapt the software tool to the Child Abuse Prevention problem, given the parallels between this problem and the formation of Dynamic VE. Ultimately, the goal pursued in the CAP system (DVE) is none other than finding the best combination of entities and professionals (enterprises) able to respond to a child abuse case (business opportunity) in an agile and efficient way.

In this system, the breeding environment is composed of all of entities and professionals from a region or locality. Obviously, given the set of features and capabilities of the VBE members, different combinations could arise from this environment in response to a specific case. However, the choice of the most appropriate configuration will depend on many factors among which are: the own case, the capabilities and properties of the breeding environments members, the past experiences, the priority criteria, etc.

Taking into account all of these factors and through the interaction of the different agents the more adequate decision sequence emerges, leading in turn to a DVO. Once the child abuse problem is solved, this configuration will no longer make sense and will disappear, releasing entities and professionals to set up new DVOs. This new approach allows us face the CAP problem from a virtual perspective, giving us the opportunity to introduce the concept of Virtual CAP system.

4.3 Analysis of the VCAP multi-agent expert System

The analysis of the platform has been made following the steps defined by Nikraz, Caire and Bahri [16]. Thus, we have identified the different types of agents and users in the system, along with their responsibilities and the acquaintance relationships that exist between them. The result is the agent diagram shown in Fig. 1.

Taking into account the agent container structure of JADE (Java Agent Development Environment), there is a main container on the manager server (see Fig. 2) in which the
VCAP Management Agent resides, in addition to the Information Provider Agent, the Yellow Pages Agent (where the Resource Agents register their services) and the rest of agents for the management of the Jade platform.

We have considered that all of these entities can provide their core business and, at the same time, be the initiators of the DVO formation process. It is also possible that a third entity or person starts the process, but for now we just consider that the system is open only to the VBE members. Perhaps in the future the platform can be open to everyone, but previously it is necessary to solve different security problems.

The union of these remote containers with the main container comes into a distributed agent platform, as can be seen in Fig. 2.

### 4.4 VCAP Platform

As we have mentioned, the current development of the VCAP platform is possible thanks to our experience in the creation of the DVEBreeder application. The VCAP platform, like its predecessor, is a software tool that combines multi-agent technology with expert systems: this combination provides us with multiple interesting features.

On one hand, communication between agents is trivial thanks to the platform used in the MAS development, which is none other than Jade. On the other hand, agents’ behavior is quite similar to the behavior human experts can have thanks to the JESS expert system (Java Expert System Shell), which allows to express the behavior of the agents as a set of facts and rules.
Furthermore, it is flexible, dynamic, scalable and, as we have seen, innovative both from technological, organizational and conceptual standpoints (for its full compliance with the initial model). Agents are autonomous, behaving intelligently and communicating asynchronously. FIPA standards are met, the interface is intuitive, the code reuse is simple thanks to its open structure, etc.

The result is an innovative tool able to solve the CAP problem in an agile and efficient way. Fig. 3 shows a simplified scheme of the platform VCAP in the considered application domain.

This new architecture is characterized by an intensive use of technology and by agility in responding to any new need or change in the environment. This agility is a key element to resolve a problem as complex in contemporary society as the child abuse. With this idea in mind, we have directed our work towards the creation of DVOs able to provide a quick and efficient response to any child abuse situation.

Based on this, the article has presented a multi-agent expert solution in which DVOs emerge in the context of VBEs. For its development, we count with the experience in the implementation of the DVEBreeder for the DVE creation.

Fig. 3. Simplified scheme of the VCAP platform.

5 Conclusions

The rapid development of the Information and Communication Technologies has radically changed the way the problems are being addressed in many areas of research and application. In turn, it has allowed developing an incomparable framework for the creation of new organizational forms with innovative and interesting possibilities, like the Dynamic Virtual Organization paradigm.

Modularity and flexibility of this platform allow us an easy adaptation to any application domain (for example, the installation of solar photovoltaics, the shop floor control problem, the prevention of child abuse cases, etc.). These qualities are certainly a competitive advantage over other similar tools that exist in the literature [8, 17, etc.] which are usually built ad hoc the problem they try to solve.
After doing the planning and analysis, we are currently working in design and implementation phases. To do this, we need to define some elements of the platform as e.g. the application domain ontology, service descriptions, agent decision modules, etc. Others, such as the interactions, message templates, interaction protocols or the ontologies for the management of the platform, are very similar to those established in the DVEBreeder tool, which will greatly facilitate the final implementation of the platform.

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7 References


