INNOVATIVE MODELLING OF SOCIAL NETWORKS FOR REPRODUCING COMPLEX SCENARIOS

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ABSTRACT

The development of simulators able to reproduce the social network dynamics and their reactions to events and actions is a promising sector for extending the potential of Modeling in modern scenarios; in these contexts the simulations are usually devoted to support training and decision making. In particular it is interesting to reproduce the web social networks as interoperable simulators with main scenario models. The authors propose an approach for creating models of people and related web social networks to recreate their dynamics during simulation runs, experimentations and exercises. The paper presents an example of using this system to address complex scenarios where human factors are fundamental.

Keywords: Human Behavior Modeling, Social Network Simulation, Interoperable Simulation, CAX

1. INTRODUCTION

The major web social networks, currently ruling the life of a large part of the world population, have been launched at the beginning of third millennium (e.g. Linkedin 2003, Facebook 2004, Twitter 2006, Instagram 2009, Whatsapp 2010). Their diffusion turned viral and they evolved in harsh competition each other addressing specific needs and categories of people by changing theme as well as capabilities and characteristics (Kramer et al. 2017).

These social networks evolved very quickly thanks to the ideal set of boundary conditions and to the synergies with emerging technologies; indeed they turned to be a fundamental part of the social interactions for millions of people in few years (Larosiliere et al. 2017). Today is very evident the influence of social networks on public opinion and vice versa, so it could be expected that these contexts represent key elements for global decision makers in order to understand the situation and to control the effectiveness of their actions, considering that the networks are reacting dynamically to each event (Bond et al. 2012). Therefore, till today, in modern training processes, such as that one in CAX, it is much more common to adopt predefined scripts with main focus on traditional media respect dynamic web networks even due to the shortfall to model these entities (Cayirci & Marincic 2009). Indeed the main focus on traditional media (e.g. press releases, broadcasting, etc.) is dictated also by historical reasons and consolidated *forma mentis*.

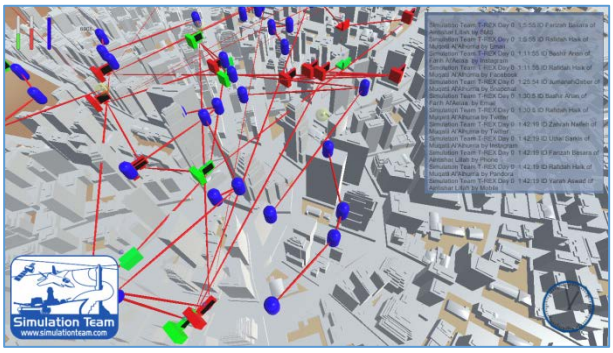

Figure 1 – T-REX Social Network Simulation

Therefore the experts identified the necessity to develop new models for properly address new frameworks, such as web social networks, as well as new challenges as Hybrid Warfare (Davis 2015; Bruzzone et al. 2016). It is evident that traditional media are still important and, obviously, they are interacting dynamical with social networks, but the principles ruling them are quite different (Keeton & McCann 2005). The new media channels are fast and diffused and their impact is very evident in politics and economics (Bond et al. 2012). In facts, the experience on specific cases such as recent USA elections confirmed that web social networks are often more effective respect traditional media, just for their capability to guarantee a continuous and quick connection with people and by targeting specific concepts and emotions (Enli 2017). The modern global scenarios are very strongly related to human factors: a very good example is the case of Hybrid Warfare (McCuen 2008; Baker 2015; Di Bella 2015; Lamb 2016). In this framework the use of models and technologies to develop effective capabilities, innovative doctrines and to create valuable training programs is fundamental (Gerasimov 2013 & 2016). Due to these considerations, it becomes critical to develop new simulators able to embed web social network into models to support decision making and training. This approach allows, with the modern complex scenarios, to extend the considerations carried out about Society Modeling since several decades (McLeod & McLeod 1984). In this paper, the authors present the analysis of the context and the conceptual model architecture as well as the preliminary results and scenario definitions for testing this approach.

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2. WEB SOCIAL NETWORKS

In particular the smart phone evolution (e.g. computational power, memory, autonomy, camera capabilities, GPS, etc.) resulted to be the biggest driver for promoting, in practice, the potential of the IoT (Internet of Things) concepts (Silva et al. 2017); obviously the Internet Infrastructures acted also as a main stream, supporting this diffusion as well as being enhanced by the business opportunities generated by this approach itself (Wu et al. 2017). In facts, the web diffusion, availability, reliability and growth of mobile bandwidth allowed to develop almost real time interconnections much reliable than any other kind of previous communication/sensor networks (Rahman et al. 2017). This trend has further evolved in terms of Apps devoted to provide new services based on the Shared Economy approach (e.g. Amazon.com since 1994, Tripadvisor since 2000, Uber 2009) that further reinforced the interactions among people on cyber dimension (Turban 2015). The incoming future poses large emphasis on cloud solutions able to simplify and extend the capabilities of the different Hardware and Software systems, so it is expected to further promote this evolution in this direction (Hashem et al. 2015). The new I/O (Input/Output) devices proposing immersive Mixed Reality (MR), combining Virtual and Augmented Solutions, are promising a step towards new integration of the social networks with the human senses; this could produce breakthrough changes respect many different aspects that affect human behavior, especially for new generations (Cartwright et al. 1960; Parking 2016; Bruzzone et al. 2016; Boulus et al. 2017; Holyst 2017). Indeed, it is interesting to note that Psychologists and Sociologists are studying new phenomena and emerging behaviors in the Society and in the new generations that result in different attitudes, different trustiness concepts and different ethics (Luo 2009; Lehavot et al. 2010; Kahneman 2013; Harbeck Voshel et al. 2015).

In facts, it is also important to note that this picture corresponds to the creation of really immense Big Data soliciting many actors to use, support and sometime even abuse these opportunities (Chambers 2016).

In terms of Business several Applications have been very successful in this sense as they created connections with social networks to collect feedback, develop mutual trustiness, provide benefits to users and, obviously, promote services and products (Turban et al. 2015).

Vice versa, there are also several negative cases, such as that ones related to the use of camera and microphone enabled device “always on” capturing private media, often used among families or even minors (Gibbs 2015); these aspects raised, recently, several issues to the Federal Trade Commission in USA (Gray 2016). It is interesting to note that the different generations and geographical areas have approached web social networks in specific ways along the last decade with communalities and differences (Xenos et al. 2014; Fox & Moreland 2015; Dong 2017).

Today it is evident that social media and networks are fundamentals in influencing the politics in both domestic and overseas scenarios (Bond et al. 2012; Wolfsfeld et al. 2013; Kwon & Hemsley 2017); it is evident that this impact introduced also several issues about reliability of information collected on the social networks and capability to diffuse fake news and manipulate public opnion (Enli 2016; Paquet-Clouston et al. 2017). Due to these reasons it is currently pretty interesting to develop model of web social networks and the related diffusion of communications and examples (Bruzzone et al.2014b; Wang et al. 2017).

3 HYBRID WARFARE & POPULATION

Hybrid Warfare is a modern concept that is raising several issues, being sometime considered to be improperly named and referring to techniques and concepts consolidated since centuries (Hoffman 2009; Murray & Manson 2012). In facts, applied examples of Hybrid Warfare are dotting the human history, therefore today the reality, with its web social networks, IoTs and alternative media, is multiplying the effects of these warfare techniques by creating a really new framework pretty vulnerable to new technologies and socio-cultural attitudes (Gerasimov 2013 & 2016). Indeed the modern hybrid warfare actions are often addressing events with a very big media impact such as scandals and terrorist attacks (Keeton & McCann 2005; Bachmann & Gunneriusson. 2014; Krug 2017). Today, hybrid warfare addresses population and consensus in order to create critical conditions forcing the opponent even to capitulate on major goals of the attackers, without moving to traditional war (Galeotti 2016); a very good example is provided by the case of recent South China Sea disputes carried out as not armed conflicts (Blinka 2017). These considerations make it evident that the capability to simulate a complex modern scenario requires to consider the effect of these actions on population as well as the dynamics of web social networks as reactions to events and activities carried out on other layers, such as military operations, terrorist attacks, political, economic contexts, etc. (Bruzzone et al. 2016).

4 HUMAN BEHAVIOR SIMULATION & INTELLIGENT AGENTS

In order to properly simulate the web social networks is necessary to model the human factors and social interactions affecting the people perception and the mechanics of communication that are diffusing information among the population, over the different channels, from face to face to social media (Soller 2001; Abrahams et al. 2005; Santos et al. 2011; Bruzzone et al. 2014a). Considering these aspects, it results evident the opportunity to develop models adopting intelligent agents to reproduce the population and its dynamics (Wooldridge & Jennings 1995; Sarjoughian , Zeigler & Hall 2001; Bonabeau 2002; Sokolowski & Banks 2011; Massei et al. 2014).

Figure 2 – Communications and Diffusion on web

This opportunity could be further reinforced by adopting a distributed interoperable architectures that enable the people models to interact with other simulators during the dynamic evolution of the scenario (Hamilton et al. 1996; Smith 2002; Zacharewicz et al 2008; Bruzzone et al.2016). The authors used extensively the IA-CGF (Intelligent Agent Computer Generated Forces) developed by the Simulation Team to reproduce the population based on a multi layer structure (Ören & Longo 2008; Bruzzone et al.2014a).
This model includes Entities & Objects (e.g. as military units, PSYOPS centers, etc.), people (e.g. individuals and small groups composing the whole population) and interest groups (e.g. a leader, an economic group, a religion, etc.), all interacting mutually and with other models (Bocca et al. 2006). This structure is designed to be able to interoperate with other models by adopting HLA (High Level Architecture) and it has been successfully experienced in many different applications including CIMIC, Cyberwarfare, Urban Disorders and Joint Multicoalition operations (Bruzzone et al 2015; Massei & Tremori 2014b).

5 MODELING THE WEB SOCIAL NETWORK

The authors decided to develop models of the web social networks by making them interacting with the IA-CGF within a MS2G (Modeling, interoperable Simulation and Serious Game) application, named T-REX (Bruzzone et al. 2016). Indeed the combination of serious games and interoperable simulation has a great potential in education and training on new issues (Raybourn 2012; Bruzzone 2014b). In facts, T-REX simulation includes towns and villages as well as threat networks and population (see figure 1). The proposed scenario includes multiple towns with their specific Population and related Social Networks; the People Objects, reproducing the individuals, reacting to events, communicating and generating elements to populate the web social networks, while Trustiness and Belief evolve dynamically based on actions, decisions & events.
In facts, in the proposed model, the nodes of the threat networks as well as the structure of the population is mapped by using Intelligent Agents (IAs).

The IA are enabled to move over the terrain in consistency with their life cycle and characteristics and to interact each other and with other entities; each IA is characterized by a set of variables that includes among the others:

- Absolute Position (i.e. latitude, longitude & altitude)
- Logic Position (e.g. at home)
- Life Cycle Type (e.g. blue collar)
- Home Location (e.g. position)
- Work Location (e.g. position)
- Interpersonal Relationships (e.g. connections to family members)
- Gender (e.g. male)
- Age (e.g. 20 year old)
- Health Status (e.g. severely sick)
- Activity or Operational Status (e.g. working)
- Ethnic Group (e.g. Caucasian)
- Tribe/Clan/Urban Group (e.g. EAKL syndicate)
- Religion (e.g. Christian)
- Political Party (e.g. social democratic party)
- Social Status (e.g. worker)
- Educational Level (e.g. high school)
- Coolness (e.g. steady)
- Crisis Ready Level (e.g. unexperienced to face crisis)
- Human Behavior Modifiers (e.g. Aggressiveness, Stress, fatigue and fear)

Even the members of the threat network have such characteristics, indeed the threat network member have the following specific characteristics:

- Threat Type (e.g. terrorist, quisling, sympathizer, occasional contact, not involved)
- Threat Status (e.g. sleeper, active)
- Threat Awareness (e.g. unidentified, identified, tracked)

In this way the simulator reproduces the life cycle of the population and individual behaviors. At this point it could be defined the conditions that activate communications among the people with special attention to two different kinds:

- Communications among individuals in the Threat Networks: these communications are not restricted to that one among terrorists, several ones are going through people that is supposed to be part of the network due to occasional contacts, coincidences as well as intelligence failures; these additional communications introduce challenges in properly identify the real threats and tracking them.
- Communication among population reacting to scenario major events that are generated stochastically based on social models reproducing human behavior and diffused among the population.

In both cases it is created a specific kind of object that represent the information published in the web social network as well as the network itself with the relative characteristics of connectivity and member preferences. In this way, an information diffused over a social network diffuse inside it, as well as outside, considering the connections with the people objects.

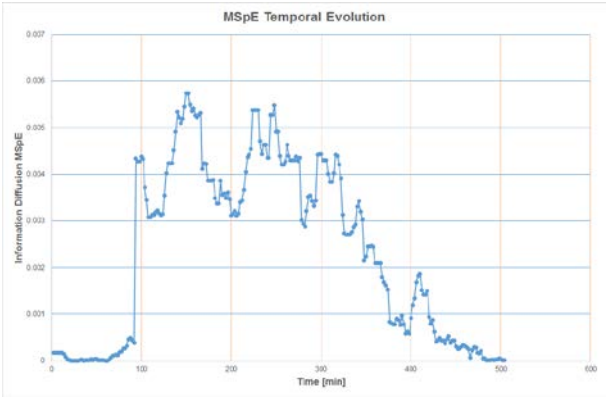

Figure 3 – Communications and Diffusion on web

The use of historical and statistical data support the fine tuning of these models even if obviously the validation is quite challenging and requires experimental tests (Balci 1994; Mastrosa et al. 2012; Liu et al.2016). In our model each web social network requires to be defined in terms of diffusion, average number of connections, user publishing intensity and frequency, trustability.
The authors experimented the first kind of communications on hybrid warfare scenarios as proposed in figure 2. In this case it has been used a scenario involving cyber attacks and media attacks over a region with a large city and four medium size town.
The attacks reproduce cyber actions on a critical infrastructure that involve a power station, a tank farm, a desalination facility and an oil port terminal (Bruzzone et al.2016).
In this context the scenario requires also to model the ICT infrastructure and cyber events and their impact on population (Theohary 2011; Damodaran & Couretas 2015). The dynamic validation has been based on temporal evolution of Mean Square Error related to the time required to diffuse the information of the attack over the population as proposed in figure 3.
Currently they are working on implementing the second type for reproducing specific web social networks in a complex scenario.

6 WEB SOCIAL NETWORK FOR CAX: SCENARIO FOR THE SIMULATOR

CAXs (Computer Assisted Exercises) are good examples where web social network simulation could provide a great benefits in different way:

- Capability to early recognize symptoms and effects of their to COE (Course of Actions) by the automatically generated response of the Social Network Simulator coupling population reaction
- Experiencing dynamically and interactively the dynamics of Web Social Networks as a main feedback to properly react to scenario evolution
- Capability to understand the dynamics of population in complex scenarios
- Develop skills in operations carried out in scenarios heavily affected by Human Factors and involving Populations and Social Networks

For these reasons currently the authors are defining a scenario and a set of Key Performance Indexes to test on the field the capabilities of the proposed Human Behavior Models (HBM) and Web Social Network Simulators.

CONCLUSIONS

The current paper outlines the opportunity to develop models of web social networks and their dynamics as well as the potential to be used in different applications. Currently the authors are experimenting, over different mission environments, the capability to reproduce these phenomena and to measure the related aspects in order to conduct investigative analysis on them; in addition the authors are fine tuning the proposed scenario as reference case study to be used for future researches in order to assess the potential of this approach within CAXs. In the next future, the authors are planning to further develop these models in order to extend the verification and validation of this approach and to diffuse the use of these simulators in real exercises to fill up the training gap related to web social networks.

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