The LabRint Serious Game: A New Intelligence Analysis Methodology

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Abstract. LabRint provides intelligence analysts with a set of learning experiences The game focuses on three stages of intelligence analysis: information collection and structuring, inference schemes development, and determination of inferences about the issue under scrutiny. To that end LabRint innovative approach implements two methodologies: the W^4HW information structuring, and the association of two graphical models for inference determination: Graphs of Deterrence and Bayesian Networks.

Keywords: Bayesian Networks · Graphs of Deterrence · Inference · Inference schemes · Information structuring · Intelligence analysis · Serious games · Strategies playability

1 Introduction

The fast development of digital technologies increases exponentially the generation of information coming from multiple sources. It thus makes a priori the work of intelligence analysts more complex. In this context, the FP7 European project LEILA (law Enforcement and Intelligence Learning Applications) provides law enforcement organizations with innovative learning methodologies for improving Intelligence analysis (IA) capabilities like [1]):

- filtering and analyzing massive amounts of data
- awareness of cognitive biases
- critical and creative thinking
- decision making in a complex environment generating cognitive biases, and under social and time pressure.
- communication and collaboration.

To this end, LEILA elaborates learning experiences, offering the possibility to actively acquire the IA skills (learning by doing), and computerizes them under the form of serious games like LabRint. In the present paper, Sect. 2 lists some of the core conceptual foundations considered in LabRint and how their consideration translates into the game workplan. Section 3 focuses on the issue of information structuring. Section 4 describes the technique that LabRint players must apply in order to develop in a visualizing manner the inference scheme on which the conclusions drawn will be

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based. Section 5 considers various possible types of game play. Last, Sect. 6 defines the players performance indices used in the game.

2 Core Conceptual Foundations and Work Plan

Intelligence analysis requires a variety of skills and competences, including knowledge of various factors or tools like:

- psychological and cultural factors explaining specific behaviors
- cognitive and decision making biases generating errors in data interpretation and related decisions
- preferences elicitation stemming from past choices
- formal logic connecting various facts or data with each other, providing in particular argumentation assessment
- rational decision-making techniques enabling to draw appropriate conclusions

LabRint, addresses these issues in an interrelated manner, covering both the associated theoretical and practical perspectives. This translates into a work plan based on an iterative and action oriented user-centered approach that involves different actors and guarantees the substantive quality of the technological research. The actors include:

- end-users
- experts in the different domains of conceptual foundations
- specialists in education
- technological and learning game designers having the ability to translate the theoretical issues into engaging learning experiences.

The work plan also includes the development and implementation of pilot sessions providing demonstration and evaluation of these learning experiences.

3 Information Representation

Information representation and analysis is a core issue in many domains of human societies, like education, business intelligence or intelligence analysis, sociology, psychology and medicine. For instance, some pedagogical models, like the successful Finnish one according to the PISA ranking, have introduced the usage of concept maps [2], even at the level of primary schools. The pupils receiving raw information from the teacher use these maps to structure the information and give it an appropriate meaning. The structuring process enables them to memorize that meaning more easily than if it had been entirely and directly given by the teacher.

The standard approach is often to let the learner or the trainee develop inference schemes, i.e. schemes representing causal relations between various evidences, and enabling thus to draw a meaningful conclusion (inference). To that end, in various domains like medicine [3] or intelligence analysis [4], a particular type of inference schemes, called Bayesian Networks (due to the use of conditional probabilities according to the so called Bayes Rule) has been applied. Although quite successful in several domains, Bayesian Networks raise two kinds of problems:

- They assume that some probabilities at least are available
- The complexity of the techniques used might increase exponentially with the size of the issue at stake, and is in the overwhelming majority of cases out of reach of the trainee or the learner, especially if the latter is a pupil in a primary school.

On the other hand, many issues, like the ones addressed in the Finnish education model, do not deal with probabilities, but rather with argumentation. Now argumentation has been the subject of significant development, especially for legal applications through resorting to what is known as Dialog Games, in which one player, the defender, makes a statement and tries to justify it, while the other player, tries on the opposite to refute all the defender's arguments. More recently, another alternative has been developed, based on a particular type of qualitative games (in the sense of Game Theory), called Games of Deterrence [5]. These games provide inference schemes under the form of graphs in which, given two nodes A and B representing each one some information, there is arc of origin A and of extremity B, if and only if A true implies that B is false. Several applications have already been developed, like the serious game called LabRint, developed within the framework of the EU FP7 LEILA project (Law Enforcement and Intelligence Learning Applications) in which the trainees have to draw conclusions from a set of raw data, some of them purposely generating cognitive or decision biases.

4 The LabRint Serious Game

The LabRint game includes two core elements: a structuring method for standard information analysis and inference schemes that connect different chunks of information and enable to draw conclusions about the issue under scrutiny.

The LabRint game provides a scenario in which the players will have to develop an intelligence analysis process, through using the toolbox in order to answer a question or a set of questions.

4.1 Structuring Method for Standard Information Analysis

The method used in LabRint for standard information analysis, is very well known in the field of marketing under the denomination W4HW meaning:

WHO does WHAT, WHERE, WHEN, HOW and WHY

So each data set provided to the player, will have to be transformed by the latter into a W4HW structure, which will be called an evidence. Figure 1 shows on the example of the first chunk of information made available to the player, how this player should proceed.

This first chunk of information has the label I01. To break it down into the W4HW structure, the player has to click on each column and select the element that

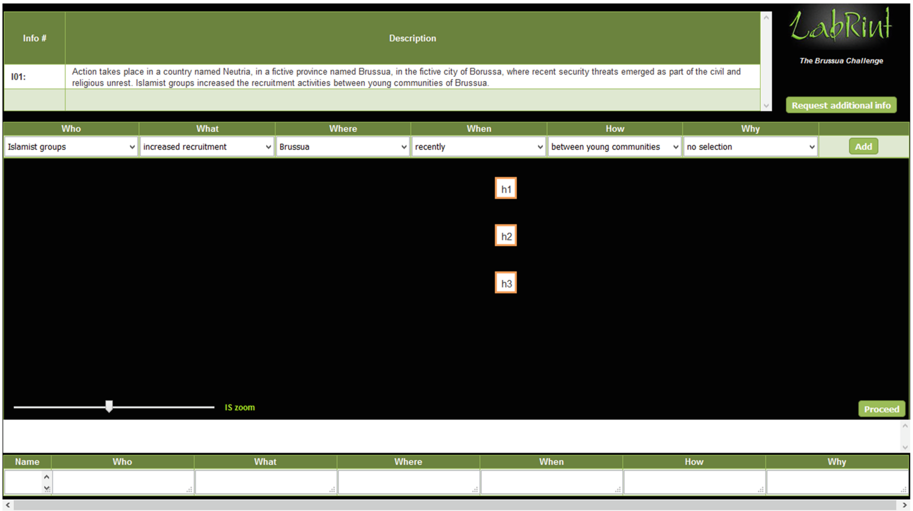

Fig. 1. The LabRint interface

appropriately represents the issue in the chunk of information. Just to give an example, in the column WHO the appropriate selection should be “islamist groups”. As in real life sometimes, the information provided to the player may be incomplete. In particular, it may not enable him/her to completely fulfill the W4HW structuring process. This is fully taken into account by the system supporting the game. This means for instance that if for a given chunk of information, no date appears, then the item that appropriately describes the situation in the column WHEN is “no selection”. But of course if the chunk of information included a date, then choosing “no selection” in the column WHEN, will trigger an error message from the system. When all 6 dimensions of the W4HW have been addressed, the player clicks on “add” and the system will reply by providing on the screen an icon “Ev x” where Ev stands for evidence and x stands for the evidence number.

5 Inference Schemes and Conclusions

Determining the inference schemes associated with the case under consideration is a core task of the LabRint game. Following the Oxford Dictionary, one can define an inference as “a conclusion obtained on the basis of facts and reasoning”. On its side the United Nations Office on Drugs and Crimes considers that “in any criminal investigation, the objective of the analysis is to find an explanation of what the information means. This explanation is called inference”. To find an inference, one needs to: gather data which concern the issue under scrutiny, analyze the consistency of the data set (i.e. determine the possible contradictions between the data composing that data set) and finally determine the conclusion/inference that can be drawn from this consistency analysis. One important point that must be stressed upon is that, in the present version of the LabRint game, for the sake of simplicity, a fact or a data which is the subject of no denial, is considered true (of course, such assumption might be questioned). So, in order to be able to draw conclusions on the basis of all the information collected, the player will first determine the denial relations that exist between the evidences built by the player with the W4HW approach. Thus, let Ev x and Ev y be two evidences built by the player. Let us suppose that if Ev x is true, then Ev y is false. This denial relation may be represented as follows (Fig. 2):

Fig. 2. Denial relation

In a figurative sense, this is as if Ev x was "shooting" on Ev y. Now of course, this does not necessarily mean that Ev x is true and Ev y is false. Imagine for instance a third evidence Ev z such that if EV z is true, then Ev x is false. The associated representation is then (Fig. 3):

Fig. 3. Three evidences

This means that if the three evidences are the only ones to be considered, then: Ev z is true, Ev x is false and Ev y is true.

Let us last consider that the issue at stake is to determine if a given assumption H is true or false, given that the inference scheme is the following (Fig. 4):

Fig. 4. Three evidences and an assumption

It stems from what precedes that Ev z true implies Ev x false which implies Ev y true, which in turn implies H false. Of course not all inferences schemes are linear paths like the ones above. Consider for instance the following inference scheme (Fig. 5):

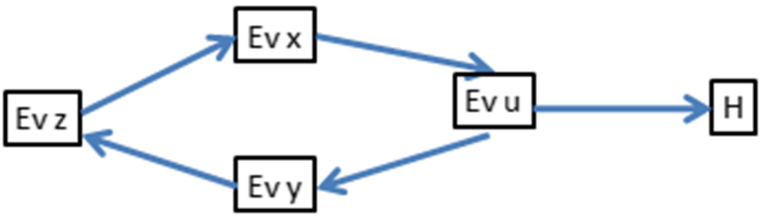

Fig. 5. Non-linear evidences path

There are in fact two possibilities, either Ev x and Ev y are true, in which case Ev u and Ev z are false and H is true. Or Ev u and Ev z are true, in which case Ev x and Ev y are false, and H is false.

If we generalize, in the LabRint framework, an inference scheme is a graph which vertices are the evidences and the conclusions to be drawn, and which edges represent the denial relations existing between evidences.

As seen in the elementary example here above, building that graph enables to draw conclusions about the truth or falsity of assumptions. This is precisely what LabRint is about. The player has three tasks:

- Structure the raw information into evidences
- Build the inference scheme associated with these evidences
- Use that inference scheme to draw conclusions about the truthfulness or falsity of hypotheses

To build inference schemes in the LabRint Game, each time that after having appropriately structured a chunk of additional information, the user clicks on the “add” button, a new evidence appears on the screen. The player may then move the evidence by clicking on it except on its extremities (for reasons that will be given hereunder) and then move the cursor. After all structuring has been made, then by clicking on the extremities of an evidence, the player will generate an arrow (with a red cross in its middle). By moving the extremity of that arrow with his/her cursor, the player will be able to connect the former evidence to another one, or to a hypothesis that, according to him/her, the former evidence defeats (Fig. 6).

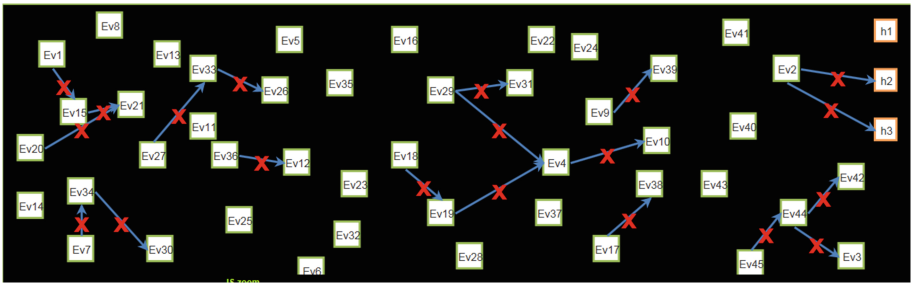

Fig. 6. A schema in LabRint

6 Performance Assessment

The game is played under time constraint, which is fixed by the trainer on the basis of: the players’ experience and the informational complexity of the game.

Given that constraint, the player’s analysis performance is assessed at two levels: the inference scheme and the conclusions. As far as the inference scheme is concerned, the system supporting the game assesses the player’s analysis performance as a percentage of the appropriate inference scheme that is being represented by the inference scheme developed by the player. With respect to the conclusions, the system supporting the game assesses the player's analysis performance as a percentage of the conclusions that are true.

To perform these analyses, the player has to click on the Proceed button, and the following screen will appear, asking him/her to confirm his/her decision to proceed, since the player will then not be able to redo the proceed without re-creating all the evidences, that is to say without re-playing the game from the beginning (Fig. 7).

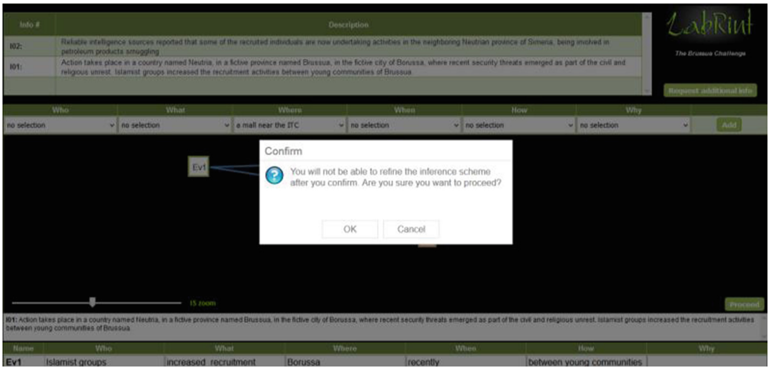

Fig. 7. Confirmation screen

If the player confirms, he/she will be asked to give his/her answers to the questions asked by the system. In the present scenario, the player will thus need to: decide whether each of the hypotheses submitted to him/her is TRUE or FALSE and then click on the Proceed button. Once the Proceed button has been clicked, the engine analyses the inference scheme developed by the player and the player's conclusions. The engine will then give the player the numerical assessment of his/her performance, as shown here below (Fig. 8).

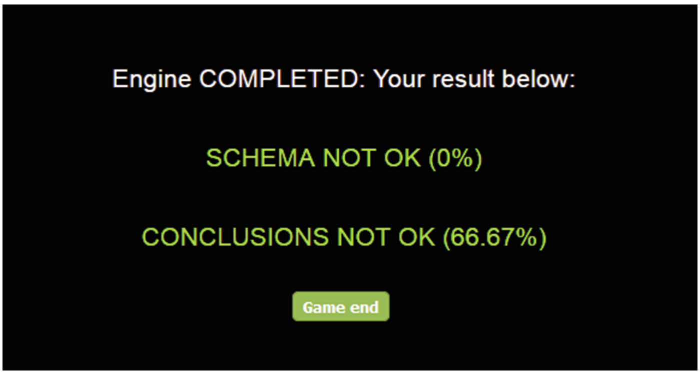

Fig. 8. Assessment screen

7 Conclusions

Serious games are an effective way for users to safely make decisions in different scenarios, even incorrect ones, and see their possible effects. Situations which are impossible to represent in the real world for reasons of cost, safety or time constraints could be accessible for users through the LEILA serious game. Serious games are a powerful tool for acquiring knowledge, training skills or changing behavior, and they can be the ideal means for intelligence analysts' training.

The LEILA learning experience will help the Intelligence Analyst to be aware of the cognitive biases, to realize when they take place, to be able to prevent or mitigate their impact in the analysis process and to dampen their effect. Through the cycle of experiential learning (exploration, experience, reflection, conceptualization) embedded in the game, the knowledge is consolidated into an experience and can be transferred (conceptualized) to several domains, enabling the intelligence community to become proactive and deploy efficient efforts to prevent criminal and/or terrorists acts.

Numerous pilots sessions have been held and will be held in many countries this year.

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