

# Work in Progress: Bayesian Networks for Edutainment

Francesco Colace, Massimo De Santo, Antonio Pietrosanto  
 Dipartimento di Ingegneria dell'Informazione e Ingegneria Elettrica - DIIE  
 Università degli Studi di Salerno, Via Ponte don Melillo, I 84084 Fisciano (SA), Italy  
 {fcolace,desanto, apietrosanto}@unisa.it

Alfredo Troiano  
 ITS Lab, Piazzale E. Fermi 1 - Loc. Porto del Granatello - 80055 Portici (NA) Italy  
 {atroiano@its.na.it}

**Abstract** - Edutainment is a neologism that expresses the marriage of education and entertainment. In particular edutainment is a form of entertainment designed to educate as well as to amuse and typically seeks to instruct or socialize its audience by embedding lessons in some familiar form of entertainment: television programs, computer and video games, films, music, websites or multimedia software. On the other hand, the design and the implementation of not boring or repetitive edutainment are not trivial or easy tasks. In this paper we propose a new approach for the design of an edutainment for medical education. The proposed environment "translates" the storyboards of the games in a Dynamic Bayesian Networks that are the extension of Bayesian Networks for modelling times-series data. The Bayesian approach allows a dynamic adaptation of the game to the user's profile and the establishment of several paths in the same game. We furnish some results obtained by the use of a first prototype of our tool in real academic courses.

*Index Terms* – Edutainment, Bayesian Networks, E-Learning

## INTRODUCTION

Ideas, facts, and things, everything that could pleasantly and effectively be communicated through a game: from this simple consideration the concept of Edutainment was born. This term was born in United States by the union of two different words: Educational and Entertainment; its meaning could be summed up in "learn by playing" and also "play by learning". By the way Marshall McLuhan said that: "Those who make distinctions between entertainment and education maybe do not know that education has to be pleasant and amusement has to be of course educational." [1]. It is in fact proved that the learning process is a less difficult task where one can experiment with, where the user is not a mere spectator but he or she becomes a main actor, or even the protagonist, of the whole formative process. This work's goal is to project and realize an authoring tool to create Edutainment, based on Bayesian Networks' formalism [3]. From the results of our analysis, we note that actual Edutainment on the market or in literature is still not able to make the most of modern technologies' possibilities. In particular, they seem to be too

static, repetitive and predictable: this makes them boring to use [2]. We also noted that the educational side for some of them is just the explication of the game, and not its interactivity, so as a consequence they appear to be similar to many other virtual games. We noted in fact that education has to unroll in a dynamic context to excite player's imagination and intuition, so to push him towards a changeable learning every time he plays [2]. It is possible to improve the quality of educative experience by using new techniques of artificial intelligence, which make the interaction with the game itself more dynamic. In this paper, we propose to investigate the potential of the Bayesian approach [3][4] in the Edutainment field. In particular we create a framework, using Java technologies, which let teachers project their own Edutainments and define probabilistically every single event that could happen during the game. The Bayesian approach, and in particular a dynamic Bayesian network (DBN) [5], allows one to measure the effects of a choice in a precise point of the game on other choices, showing to the students a series of situations with a very low degree of repetitiveness and predictability. As a case of study, we used that of a student who has to choose, through the analysis of a patient's state of health (anamnesis) and the evolution of some parameters, the best treatment. The paper is organized as follows: in the first section we provide a short description of the edutainment. In the second paragraph we will supply some details about Bayesian networks. In the third one we introduce the case of study and the obtained results.

## EDUTAINMENT

From the observation of some educational games online, we noted that a big part of them, use a hierarchy structure. In other terms it is a typical "tree" organization. Because of the main characteristics of the tree structure, when a player decides the direction to follow, the environment is completely determined; every time the user will make the same choice, this will produce the same effects, making the game predictable and repetitive. So what is important to make these games more interesting is unpredictability and in particular with an intelligence attached. For this reason, among all the techniques of realization of intelligent games, an important role is played by Artificial Intelligence which, through its

algorithm, gives the possibility to create inner engines transferring intelligence to the games. An interesting approach to the creation of amusing and stimulating games is the Bayesian one through which it is possible to let the game go on, in a probabilistic manner, according to the user's choice. In the next paragraph we will give more details about this approach.

### BAYESIAN NETWORKS

Bayesian networks have been successfully used to model knowledge under conditions of uncertainty within expert systems; and methods have been developed from data combinations and expert system knowledge in order to learn them [3][4]. A Bayesian network is a graph-based model encoding the joint probability distribution of a set of random variables  $X=\{X_1, \dots, X_n\}$ . A specialization of Bayesian networks are those named dynamic. They work with two copies of standard Bayesian networks. In particular, one represents the network in the instant in consideration (T), while the other one represent the network at the following slot time (T+1). When a dynamic Bayesian network records new evidence, the latter is added to the slot time T and through the inference process, node's values at the slide at time T+1 are calculated and the "roll-up" happens. During the "roll-up", the slide at time T is erased, the slide at time T+1 becomes the new relative slide at time T and a new copy of the network is created, which identifies itself with the slide at time T+1. By this way, a DBN is able to model some changes during the passing of time.

### IMPLEMENTATION AND OBTAINED RESULTS

In this section of the paper we will describe in detail the environment realized to build Edutainment software. The main idea is to translate the storyboard the teacher wants to use within Edutainment, into a dynamic Bayesian network. In particular, the key situations within the storyboard are represented by network's nodes. It is necessary, however, to identify within these conditions the variables of interest and the node's conditional dependencies with the rest of the network, fixing its probabilistic value. So the environment allows the teacher to design the network through the definition of: 1) several nodes, 2) variables of interest and 3) the links among them. In particular the node represents the situation while the variables of interest are the choices the user can make. Teachers can associate a textual description of the situations, related images and formative contents to every node. The textual description and the images will be furnished to the users during the games while the formative contents can be offered to the students in order to improve their preparation. We have to underline that the teacher, defining the probabilities of every network nodes, allows the creation of several paths according to the users' choice and the Bayesian approach. On the other hand, the use of dynamic Bayesian Networks approach allows a continuous updating of the network. In this way the students have to deal with a changed network and with new situations. Obviously the new status of the network is function of the choices of students and

of the evolution laws associated to the various nodes. To test the proposed approach we proposed to design a game allowing the first year students of the faculty of Medicine to diagnose some diseases starting from the anamnesis of the patient. The projected Edutainment allows the student to check the performances of the different parameters of interest according to the spending of time and the choices made by the student. Every time that some remarkable event or parameters join critical values, in other words when students make some mistakes, our system supplies some formative contents, previously selected by teacher, in order to improve their training process. The game has been used by about 25 students for 250 times. Our system proposed the same situations in the same order only the 10% of the cases. In this way users have to manage and solve news and unexpected circumstances. Through a valuation questionnaire we also checked how much the students appreciated this kind of approach. We submitted an evaluation questionnaire also to the teachers involved in the experimentation. At the end of course teacher noticed that the students involved in the experimentation achieved good results in the understanding of the proposed subjects. They noticed, in fact, that students had more time to train themselves by the use of the proposed environment. As previously said we investigated student's opinions through suitable questionnaires. They declared to have appreciated the opportunity to work with this tool and this approach because it is amusing, in this way they can optimize their study-time and to feel comfortable with this kind of interaction. In conclusion, it is our opinion that the use of this environment has been successful in both the investigated situations. In this moment our tool is a stand alone application and we furnish it to the students by the use of CD-ROM. We are working to a web based version of the tool. On the basis of these results, we are currently planning to further experiment the system and to study in more details pedagogical models for applying it.

### CONCLUSIONS

In this paper we described the use of dynamic Bayesian networks to create Edutainment. The choice is revealed particularly effective and appreciated by the students. Future developments could concern the combination of the proposed method with expert systems so to make the game more unpredictable and customized.

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