**Title : An ontology-based model-driven game engine for medical consultation simulation**

**Abstract:** Communication and interpersonal skills for general practitioners in medical consultation play an important role in providing high-quality health care and establishment of good doctor-patient relationship. However specific training on communication skills for doctors and medical school students are often overlooked. Comparing to traditional training approaches by using role-playing and hired actors (standardized patients), an educational tool in form of the game can maximize the variety of scenario, reduce the limitation and enhance learner’s motivation. For the above purposes, this article aims at modeling in medical consultation process and developing a game engine based on these models that applied to medical consultation simulation. A domain level ontology is introduced to enable creation of phrases repository and query in this phrase repository with rules. Our proposed models are meant to provide flexibility of creating different profiles of patients, modifiable to respond to specific learning objectives and learner’s profile, and a maximization of scenario in the game.

**Introduction**

*-- background: importance of communication skills and lack of formal training on it*

Though identified by many researchers and experienced doctors as an important component of patient care, communication in medical school curricula was incorporated informally as part of teaching rounds and faculty feedback, and specific training on communication skills for doctors haven’t been received much attention [cite]. In previous studies effective doctor-patient communication has been shown to have a positive impact on a number of better health outcomes, such as help to detect problems earlier, decrease risk of malpractice and higher satisfaction from both patients and doctors [cite]. The importance of communication between doctor and patient has started to be recognized and teaching of communication skills begin to be included in many undergraduate and postgraduate learning programs for the benefit of both doctor and patient.

All of these training programs require expert teachers. Training is most effective when conducted in small groups, in which individual physicians get direct supervision. Furthermore, learning is more likely to change physician communication if there is reinforcement over time, in repeated educational sessions

Besides the usual case of doctor-patient situation in general practice, a triadic relation may be introduced by the presence of an intern student, as for medical students an internship that allows them to practice clinical skills with real patients of experienced doctors as their directors is due on their senior years of study. Doctors as directors of intern students are in charge of analyzing trainees’ behaviors and decisions, most of the time in-real-time along with patients to help trainee with their learning. The presence of intern student may disturb the patient. As a result, general practitioners should also know how to deal with this kind of challenges.

*Therefore Toulouse College General Medical Department (DUMG) is conducting experiments on medical consultations: Medical consultations led either by a director/trainee team or just by the trainee are video recorded. Those records are used in order to debrief trainees as well as their directors. DUMG is in association with the Research Laboratory in Broadcasting (LARA) of Jean Jaurès College and the Research Institute in Computing (IRIT) of Paul Sabatier College work on the data treatment of the video records. The partnership of those three institutions will enable them to write screenplays of new medical consultations. The use of those video sequences will be systematized and streamlined by integrating them into digital tools such as e-learning or serious games. This software will help building scripted and interactive medical appointments. Then, tutors will use those appointments to make lessons adapted to their goals. Serious games aspect will allow trainees to play as a doctor in front of a virtual patient. Trainees will be able to discover and test many situations all by themselves. They will also be able to consider the different consequences of those decisions, in particular contingency management in a context of uncertainty.*

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We have identified from domain knowledge, that methods for measuring doctor’s communication skills include direct observation of communication behavior (like what DUMG currently are doing by using videotape of meeting or watching actual encounter between doctors and patients), interview or surveys with patients about their health care experiences, and actual health measure [cite]. In particular, for the first interview between a GP and a patient, the objectives of GP is to firstly identified all the useful information about the patient as possible, like administrative information, health history and current symptoms, and secondly carried out a summary of patient illnesses and concerns and decide a treatment plan according to the priority of current identified problems. For each dialogue session information given by patient will be recorded

-- *Introduction of serious game on this education*

The main objectives of education and training for professionals are to build or consolidate a diverse set of skills. As a new powerful tool for learning and training, serious games have been used in health care area for various advantages such as immersive and independently learning, risk-prevention, and motivation-driven engagement for learners. As a learning tool the serious game allows learners to progress in repeated education session and go through scenarios again to practice a new approach.

In this context, we decided to develop a serious game to train non-clinical skills that aims at providing higher quality health care. Currently the game pedagogical objective focuses on communication skills during the medical interview under different kinds of situations. The prototype of the game is targeted to medical school students in general medicine, and also general practitioners in charge of intern students during their internship or for continuing education. The player-learner will play the role of a doctor and face his virtual patient in the game during simulated medical consultation interviews.

Game engine of this game should allow easy modification of game scenarios for multiple reasons. On the one hand, for the diversity of scenarios as well as different kinds of situation that holds different objectives in communication skills learning, the game should be able to adjust according to these situations. On the other hand, knowledge on *good communication skills is hard to define by simply judging the correctness of a learner’s behavior*. Thus in order to reflex user’s performance by using relevant game elements, such as recompensing system (rewards/punishments) and interface display, a tailorable system in game design is necessary. What’s more, the behaviors of virtual patients are influenced by elements other than criteria on good communication skills. For instance, a patient with aggressive character will act differently from a patient with easy-going character, even as other aspects in profiles of these two virtual patients are totally the same. Besides, the current relationship between a doctor and his patient can also change the behaviors of the patient, as a patient with more confidence on his doctor is more like to choose to agree with his doctor’s decision even when he has doubt. We keep this knowledge authorable so that domain expert can configure the system and adjust the behavior of virtual patient with a specific learning objective.

To accomplish *this task*, we have firstly identified sub-process in medical consultation process as so called “micro-sequences”. We also defined several concepts such as phase, dialogue sessions and phrases to describe the exchange of utterances between a doctor and a patient in medical consultation process. Then we represent this process in a formal representation by using BPMN and ontology.

The following of this paper is organized as follows: firstly we will explain the definition of concepts in the model, and then we will present MedComOnto which is ontology in medical consultation dialogue domain. Next we will present patient model. At last we will show how simulation of medical consultation works based on this model.

(methods for measuring patient-centered communication)

They are used to understand present climate and what factors create a particular climate in any one region. They are used to project climatic conditions into the future. Finally, climate models are a tool to find out what natural processes or human activities may affect a region’s environment in the future.

can simulate alternative futures and thus can answer questions about what processes may or may not shape the future environment of a regi

**Part 1: Medical consultation process modeling**

**1 concepts and syntax**

Based on studies on communication skills in medical interview such as Calgary guide, [cite Vidal], we have developed a model to simulate medical consultation process. This model can be used by game engine for the purpose of training communication skills for health service practitioners.

We will now present the key components in the proposed model where concepts of domain and syntax are defined. The mains concepts defined are as follows:

* Concept Definition 1: PHrase

Phrase is a single unit of expression that including content of utterance and non-verbal expression (a gesture like nodding or a facial expression like frown). However the psychological activity is not concluded as a phrase. Phrase has an actor as the participants and a primitive type. As for different participants in a medical consultation interview, we can have values of actors as: phrasePatient, phraseDoctor, phraseIntern, phraseOther, and values of primitive type as: question, confirmation, disagrees, puzzled.

Phrase(x): Phrase has actor x. Phrase.Type

* Concept Definition 2: dialogue session

Dialogue session is a set of PHrase with different actors around a single topic/purpose. By entering the details, phrase in dialogue session is actually a round of forward-reply among actors. The beginning of a dialogue session is called entering point, and the end of a dialogue session is called exit point. One dialogue session can have several possibilities of exit points which will lead to different scenarios. The illustration of dialogue session is shown in figure below:

* Concept Definition 3: Level

The order of a pair of Phrase by one actor and PHrase by another actor as reply in one dialogue session is called Level. Leveli =(Phrase(x) ,Phrase(y))

*Pair(level 1), Pair(level 2)*

* Concept Definition 3: dialogue flow

Dialogue flow is the sequence of several dialogue sessions. As in medical consultation process we have identified link sequences, independent sequence and parallel sequence.

* Concept Definition 4: Micro-sequence

*Contain one or many dialogue sessions*

SetMicro-sequence={dialogSession1, dialogSession2, … dialogSessionN}

* Concept Definition 5: phases

Phases are containers of micro-sequences which are segmented according to the domain knowledge and compose the whole process. The structure of phases is a set where its element is phase. Every single phase is composed by several micro-sequences which contains one or several dialogue sessions.

For example, Phases for medical consultation interview process are composed by 4 phases. They are: initialing phase, information gathering phase, conclusion phase and ending phase.

Set-Phase={phase1, …phaseN}

We have developed syntax for defining a set of rules which can be derived from the concepts:

In our proposed model, the consultation process is identified as 4 phases and *20* micro-sequences. In some micro-sequence sub-steps are identified. We call the phrases uttered by the two parties, i.e. doctor and VP in each sub-step, a dialogue session. A dialogue session has an objective that makes the two parties talk around this subject. *[here explication of: entrance of dialogue session and exit point of dialogue session]* The table below shows the phases, micro-sequences and sub-steps in phase 1 and phase 2.

As we can see from the table, in phase 1, there are 2 micro-sequences. In the first micro-sequence, there are 2 dialogue sessions: say hello and invite the patient to sit and talk. These dialogue sessions don’t have a pre-condition, which means, they are available steps in a medical consultation no matter on what circumstances. On the other hand, in some micro-sequence there are some or all sub-steps that need a constraint to be possibly reached. For example, in micro-sequence with id: B3, the content of this micro-sequence is to perform physical examination. This micro-sequence is dependent on the condition that the micro-sequence with id B2\_paraU\_B5 is reached with a return value: ok, which means the virtual patient has agreed to have the examination.

For each sub-steps, different possibilities of phrases lanced by doctor are restored in the doctor’s actions repository. For each ‘category ’ of DInitPhrase, a bunch of VPReplyPhrase id are associated. The reply phrase of VP is attributed with a Boolean variable to decide if after this phrase the dialogue session can be continued or not. If this value is true, which means this dialogue session will go on if the player choose ‘raffiner’ to continue the conversation. The following phrases in the same dialogue session that can continue to carry on the same topic are also predefined in the repository. The organization of phrases in one dialogue session is a tree structure.

**Part 2: Ontology in medical consultation phrase**

**Part 3: Patient’s profile creation**

**Part 4: Example of creation of phrase repository**

**Part 5: Example of phrase query in simulation**

*--- Previous works and state of the arts*

Currently these serious games can be classified into three categories according to their objectives: serious games for rehabilitation, serious games for education and training for professionals, and serious games for health prevention and education for public [1, 2]. Most of the serious games dedicated to the education of professionals focus on the training clinical skills in a particular area, by using a simulation-based approach. Representatives of such products are for example “Dental Implant Training Simulation” for training on dental implant practice, “Pulse!” for training clinical skills in diagnostic in an immersive virtual learning space, or “Play&Cure” for training students of 4th year medical with procedures of medical differential diagnosis [2]. In regard to communication skill training and establishment of good relationship with patients, currently little research has discussed on this topic.

*Moreover, serious games face some obstacles in the design process [3]. Most serious games have been developed without a proper design theory and have neglected integration of two key elements: educational objective and gameplay [4].*

Training focusing on patient-centered communication have been implemented in medical school to some degree, but they could be expanded particularly for medical residents.

[cite] Doctor-Patient Communication: An Important but Often Ignored Aspect in Clinical Medicine, JIACM 2010; 11(3): 208-11.

[cite] Doctor-Patient Communication: A Review 2010. Jennifer Fong Ha, MBBS

Future work: Usage of the game for other professionals in health care domain.