Work-in-Progress – Towards an Emotional Learning Model for Intelligent Gaming

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Outline of presentation

- Related work
- Emotional Learning Model
- PlayPhysics Design & Implementation
- Evaluation & Results
- Conclusion & Future Work
Background & related work

• Game-oriented learning
  – Interactive and emotional link

  **CHALLENGE:** Achieving Knowledge & Understanding

• Following Design Principles (Malone & Lepper, 1987) & Providing Adaptable Guidance
  – Intelligent Tutoring Systems (ITSs)
    (Conati & Maclaren, 2009; Blanchard & Frasson, 2006)

• Student Modelling (Wolf, 2009; Sucar & Noguez, 2008)

• Affective Gaming (Sykes, 2006)
• Approaches for recognising emotion
  • Recognising Physical effects (Sarrafzadeh et al., 2008; D’ Mello et al., 2008)
  • Reasoning about emotion from its origin (Jaques & Vicari, 2007)
    – OCC Model (Ortony et al., 1990)
  • Hybrid approach (Conati & Maclaren, 2009)

• Recognising students’ motivation (Rebolledo-Mendez, et al., 2006) & self-efficacy (McQuiggan et al., 2008)

• Control-Value theory of Achievement Emotions (Pekrun et al., 2007)
Research aim

• Creating an emotional student model to reason about the learners’ emotions from observable behaviour during game-play using cognitive & motivational variables
Emotional Student Model

- Student modelling involves uncertainty (Sucar & Noguez, 2008)
  - Which emotions must be recognised?
  - Which factors & features must be taken into account

Research Approach

- Control-value theory
- Probabilistic Relational Models approach
- Dynamic Bayesian Networks
The Control-Value Theory

• Achievement Emotions
  – Defined according to the focus & time frame
    • Prospective-outcome, activity & retrospective-outcome
  – Domain dependent

• Appraisals of control & value are the most relevant when determining & emotion
  – Motivational, cognitive & physiological variables
<table>
<thead>
<tr>
<th>Time frame/ focus on</th>
<th>Value appraisal</th>
<th>Control appraisal</th>
<th>Emotion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>High</td>
<td>Anticipatory Joy</td>
</tr>
<tr>
<td></td>
<td>(Success)</td>
<td>Medium</td>
<td>Hope</td>
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<td></td>
<td>Negative</td>
<td>Low</td>
<td>Hopelessness</td>
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<td></td>
<td></td>
<td>Medium</td>
<td>Anxiety</td>
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<tr>
<td></td>
<td></td>
<td>High</td>
<td>Anticipatory relief</td>
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</tbody>
</table>

Table 1. Fragment of the Control-Value Theory by Pekrun et al. (2007)
Figure 1. PRM based on the control-value theory.

Figure 2. PRM instance according to the time frame ‘Before’.
Figure 3. Prospective-outcome emotions DBN
Commander Damian McCarthy

To accomplish your mission it is very likely that you have to use your knowledge on the topics of vectors, the principles of linear and circular kinematics, and Newton’s laws of motion for particles and rigid bodies. What do you think? Do you think you can make it?

First Lieutenant Muñoz Esquivel

• Yes, I am extremely sure that I will succeed. I am very confident that I will handle the situation.
• Yes, I will succeed. I will handle the situation.
• Well... I do not know if I will succeed or fail. I will try to handle the situation.
• Well... may be I will fail, since those topics are difficult, but I will make all the possible to handle the situation anyway.
• Well... to be honest, I am afraid of failing, since those topics are very difficult, but I will give it a try.

Figure 2. Fragment of PlayPhysics game dialogue based on the AEQ
PlayPhysics design

• Students find it difficult to understand & apply the underlying principles of Physics

• PlayPhysics uses Olympia architecture (Muñoz et al., 2009)

• Olympia will be modified to recognise the students’ emotions & provide pedagogical actions, which involve emotional responses delivered through game elements

• The most difficult topics in an introductory Physics course were identified through an online survey – Trinity College Dublin & Tecnológico de Monterrey.

• The story-line of PlayPhysics is a space adventure
First Challenge

- Involves piloting a spaceship to Athena by applying knowledge about vectors, principles of linear and circular kinematics and Newton’s laws for particles and rigid bodies.

- Unity Game Engine, 3D Studio Max, JSPs, Servlets, Elvira & Hugin Lite

Figure 4. PlayPhysics first challenge GUI

Figure 5. PlayPhysics Player-characters
Evaluation & Results

- Pre-test & Knowing result
- Answering Game-dialogue
- Comparison between reported emotion & inferred emotion

- Evaluation of the Prospective-outcome emotions DBN

![Graph showing reported emotion vs predicted emotion for students at ITESM-CCM. The graph includes Emotion numbers 1 to 6 (Anticipatory relief, Hope, No emotion, Anxiety, Anticipatory joy, Hopelessness) plotted against the number of students. The x-axis represents the number of students, and the y-axis represents the Emotion level. The graph compares Emotion reported by the student and Emotion inferred by PlayPhysics.](image-url)
Some students did not know how to classify the emotion that they were feeling (confidence & effort).

The confidence reported by the student correlated poorly with question 5 of the game-dialogue, therefore question 2 will be used, which improves the correlation.

Some probabilities in the Conditional Probability Tables (CPTs) need improvement. Therefore the data obtained from this test will be used to adjust the probabilities.

Also the data obtained is being analysed with Discriminant Analysis to remove variables and dependency links that are not necessary.

Further tests with a larger population of students are necessary.
Conclusion & future work

• Design of an Emotional student model that reasons about emotion during game-play using cognitive and motivational variables

• A PRM approach & as a basis the Control-Value theory of achievement emotions

• The results show promise when evaluating the prospective-outcome emotions DBN. However it will be necessary to conduct further tests with a larger population of students and with the other DBNs once the implementation of the first challenge is completely finished
Questions

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