Useful Roles of Emotions in Animated Pedagogical Agents

Ilusca L. L. Menezes
IFT6261 :: Winter 2006
Objectives

- To provide opportunities:
  - To understand the importance of the emotions in learning
  - To explore how to model emotions in pedagogical agents
Presentation

- Introduction
- Overview of Emotion
- Emotion in Learning
- Pedagogical Agents
- Conclusion
- References
• **Introduction**
  • **Emotion and Cognition**
  • Overview of Emotion
  • Emotion in Learning
  • Pedagogical Agents
  • Conclusion
  • References
Emotion and Cognition

• The traditional view
  • Philosophers like Plato regarded emotion as “irrational urges that needed to be controlled through the use of reason” (O'Regan, 2003)

• The recent view
  • Emotion is related to cognition and plays a fundamental role in learning, behaviour and decision making (Salovey et al, 1990; Damasio, 1994)
• Introduction

• Overview of Emotion
  • What is Emotion?
  • Components of Emotion
  • Theories of Emotion
  • Models of Emotion
  • Emotion in Learning
  • Pedagogical Agents
  • Conclusion
  • References
What is Emotion?

• “a psychic and physical reaction (as anger or fear) subjectively experienced as strong feeling and physiologically involving changes that prepare the body for immediate vigorous action” (Merriam-Webster Dictionary)

• To understand the emotion is a difficult task:
  • Emotion is a complex term that has no single universally accepted definition
Components of Emotion (1/2)

1. Emotion can be characterised by three components:
   1. Physiological
      - Internal physical changes
   2. Behavioural
      - Outward signs of an emotional state
   3. Cognitive
      - Thoughts, expectations and beliefs
Components of Emotion (2/2)

- Example: **Anxiety**
  1. Physiological
     - Physical changes such as *increased heart rate, breathing, sweating*
  2. Behavioural
     - Facial expressions of *tension*
     - *Closed* body posture
  3. Cognitive
     - Meaning associated with this emotion, such as “I’m really worried about this presentation”
Theories of Emotion (1/4)

- Common sense
  - An event produces the feeling of an emotion
  - This feeling produces physiological changes and behaviour
Theories of Emotion (2/4)

- The James-Lange approach (1880)
  - Emotion arises from physiological changes and behaviour
Theories of Emotion (3/4)

- The Cannon-Bard approach (1927)
  - We experience physiological changes, behaviour and emotional at the same time
Theories of Emotion (4/4)

- The Schacter-Singer approach (1962)
  - Cognitive theory
  - Emotion arises of two factors:
    - physiological changes
    - interpretation of these changes (based on the context)
Models of Emotion

- Researchers have developed models of emotion based on cognitive appraisal theory
  - Ortony, Clore and Collins' Structure of Emotion (1988) is an example:
    - it was developed with the aim to implement it in a computer
    - supports twenty-two emotion categories
    - emotions arise from valenced reactions (the reactions of the emotional value associated with a stimulus), that can be positive and negative
    - the stimulus can be induced by events, by agents or by objects
OCC Model of Emotion

Figure: The original OCC Model (Ortony et al., 1988)
• Introduction
• Overview of Emotion

Emotion in Learning
  • Emotions affect Learning
  • Pedagogical Agents
  • Conclusion
  • References
Emotions affect Learning (1/2)

- Psychologists and educators have been pointed out the way as the emotions affect the learning (Goleman, 1995; Piaget, 1989)

- “Students who are anxious, angry, or depressed don’t learn; people who are caught in these states do not take in information efficiently or deal with it well” (Goleman, 1995)
Emotions affect Learning (2/2)

- **Positive emotions:**
  - generally **enhance** motivation
  - facilitate learning and performance

- **Intense negative emotions:**
  - can **block** the thought processes
  - **reduce** memory capacity (Isen, 1993) and inductive reasoning (Idzihowski, 1987)
  - can **minimize** motivation level, interfere with learning, and contribute to **low** performance
• Introduction
• Overview of Emotion
• Emotion in Learning

**Pedagogical Agents**
• Pedagogical Agents
• Architecture of a Pedagogical Agent
• Animated Pedagogical Agents
• Modelling Emotions in agents
• Recognizing Learner’s Emotions
• Designing Emotive Behaviours

• Conclusion
• References
Pedagogical Agents (1/2)

- When the Intelligent Tutoring Systems (ITS) interact with the learner, they modify their bases of knowledge, they perceive the learner's interventions and they can learn and adapt the teaching strategies according to the learner's performance.
- To make this improvement, intelligent agents are introduced in this environment and they are called Pedagogical agents.
Pedagogical Agents (2/2)

- Are cognitive agents (Frasson et al, 1996)
  - Intelligent agents
  - Autonomous
  - Social ability
  - Reactive
  - Instructable
  - Adaptability
Architecture of a Pedagogical Agent

Machine learning expertise

Cognition

Control

Perception

Action

Pedagogical expertise

Environment
(Other actors + Blackboard)

Improvement

(Frasson et al, 1996)
Animated Pedagogical Agents

- Are **animated lifelike characters** designed to facilitate learning
- Can **communicate** with learners both **visually** and **verbally** and they utilize different kinds of **emotions** to do this
- Play an important **motivational** role as they interact with learners:
  - can have a strong **positive effect** on students' learning – *the persona effect* (Lester et al, 1997)

Introduction
Overview of Emotion
Emotion in Learning
Pedagogical Agents
Conclusion
References
Examples (1/2)

- **COSMO** inhabits the Internet Advisor, a learning environment for the domain of Internet packet routing

- **STEVE** helps students learn to perform physical, procedural task, such as operating or repairing complex equipment

(Towns et al, 1998)

(Rickel et al, 1997)
Examples (2/2)

- **HERMAN THE BUG** inhabits the Design-A-Plant learning environment and helps children learn about botanical anatomy and physiology.

- **THE PRIME CLIMB AGENT** provides hints that help the student to reason about number factorization in Prime Climb, an electronic educational game.

(Towns et al, 1998)

(Conati et al, 2002)
Modelling Emotions in agents (1/3)

- Using OCC Model:
  - we need to define:
    - In the learning environment:
      - the set of events, actions and objects
    - For the agent:
      - the set of goals, standards and attitudes
  - we relate:
    - events with goals
    - actions with standards
    - objects with attitudes
  - the emotions are generated, matching these factors
Modelling Emotions in agents (2/3)

- Using OCC Model:
  - For Events:
    - an agent need to have a set of goals which help define his personality
    - these goals may match situations that arise (event) in the simulation
    - when there is a match between some event and the goal-based concerns of agent, emotions are generated
    - events can be desirable or undesirable
Modelling Emotions in agents (3/3)

- Example:

<table>
<thead>
<tr>
<th>Event</th>
<th>Desirable(D) or undesirable(U)</th>
<th>Agent’s Emotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The learner supplied a <strong>correct</strong> reply the exercise</td>
<td><strong>D</strong></td>
<td><strong>Joy/ Satisfaction</strong></td>
</tr>
<tr>
<td>2. The learner appears <strong>bored</strong> with the exercise</td>
<td><strong>U</strong></td>
<td><strong>Distressed/ Anxious</strong></td>
</tr>
<tr>
<td>3. The learner <strong>finished the chapter</strong></td>
<td><strong>D</strong></td>
<td><strong>Joy/ Satisfaction</strong></td>
</tr>
</tbody>
</table>
Recognizing Learner’s Emotions (1/3)

- A pedagogical agent needs to decide when and how to intervene the learner. For that, it has to recognize the learner’s emotions.

- Which are the mechanisms that can be used to recognize the emotions of a learner?
  - Sensors that can detect the emotions through of the voice intonation, facial expressions, muscular tension and breath.
  - We can observe the learner’s behaviour – the actions of them in system, for example: time of execution of an activity, success or fails in execution of an exercise and order of aid.
Recognizing Learner’s Emotions (2/3)

• How to recognize the emotions of the learner?
  • We can use the OCC model to recognize learner’s emotions:
    • we define:
      • the set of events, actions and objects in the learning environment
      • the set of goals, standards and attitudes of the learner
    • we relate:
      • events with goals, actions with standards, objects with attitudes
    • the emotions are generated, matching these factors
Recognizing Learner’s Emotions (3/3)

- Example:

<table>
<thead>
<tr>
<th>Event</th>
<th>Desirable(D) or undesirable(U)</th>
<th>Learner’s Emotion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The learner supplied a <strong>correct</strong> reply the exercise</td>
<td>D</td>
</tr>
<tr>
<td>2.</td>
<td>The learner supplied a <strong>incorrect</strong> reply the exercise</td>
<td>U</td>
</tr>
<tr>
<td>3.</td>
<td>The learner <strong>finished the chapter</strong></td>
<td>D</td>
</tr>
<tr>
<td>4.</td>
<td>The learner <strong>accepted the aid of the agent</strong></td>
<td>D</td>
</tr>
<tr>
<td>5.</td>
<td>The learner <strong>denied the aid of the agent</strong></td>
<td>U</td>
</tr>
</tbody>
</table>
OCC Model

● Positive points:
  ● It has served as the **basis** for implementation of several other computational models
  ● It is a **simple** model

● Limitations:
  ● It focus **only** on the **cognitive structures** and mechanisms mediating the **interpretation** of external stimuli (events, agents, objects). It does **not** give **attention** to the **physiology** and **behaviour** on emotional processing
  ● It assumes **fixed** goals
  ● It does **not** employ a **learning mechanism** of emotion
A DBN for Emotion Recognition (1/2)

- It is **difficult** to evaluate precisely the learner’s emotions
  - To deal with the high level of **uncertainty** involved in recognizing learner’s emotions, Conati et al use **Dynamic Decision Networks (DDNs)** that detect variety of affective states based on the **OCC model** (Conati et al, 2004)
  - There are several **reasons** for using DDNs to model emotions (Conati et al, 2004):
    - DDNs generate as accurate an **assessment** on the user emotional state
    - DDNs allow representing the **temporal evolution** of emotion
    - they provide **formal mechanisms** based on decision theory to **model** how an agent can rationally chose among actions with uncertain outcomes
A DBN for Emotion Recognition (2/2)

- Situations consist of the outcome of any event caused by either a learner’s or an agent’s action.
- The nodes *Goals* are the goals that a learner may have.
- The desirability of an event is represented by the node *Goals Satisfied*.
- The nodes *Emotional States* are the emotions that can be generated.
- User goals can depend on *User Traits* such as personality.
- User goals can influence user *Interaction Patterns*.

(Conati et al, 2004)
Designing Emotive Behaviours (1/2)

• To design emotive behaviours in an pedagogical agent, it is necessary to create:
  • a general behaviour space populated with emotive behaviours and another with pedagogical speech acts
  • an sequencing engine to dynamically plan full-body emotive behaviours in real time by selecting relevant pedagogical speech acts and then assembling appropriate visual behaviours
Designing Emotive Behaviours (2/2)

Figure: The lifelike pedagogical agent behavior planning architecture (Towns et al, 1998)
• Introduction
• Overview of Emotion
• Emotion in Learning
• Pedagogical Agents

**Conclusion**

• Conclusion
• Present Works
• Conferences

• References
Conclusion

- Emotions play an important role in learning
- Through animated pedagogical agents, emotions have been incorporated into the learning environment, adding motivation and increasing the learners' performance
- The OCC model of emotion was showed. We can use it not only to model agent’s emotions but also to model learner’s emotions
Present Works

- Many researchers have been developed computational models of emotion
  - EMA (EMotion and Adaptation) – a general computational model of emotion (Gratch et al, 2004)
- Works have been done with the intention to induce emotions in the learners
Conferences

- **AAAI-06** - The Twenty-First National Conference on Artificial Intelligence: http://www.aaai.org/Conferences/AAAI/aaai06.php

- **aamas-06** - Fifth International Joint Conference on Autonomous Agents and Multiagent Systems: http://www.fun.ac.jp/aamas2006/


- **FLAIRS-06** - The 19th International FLAIRS Conference: http://www.indiana.edu/~flairs06/


- **IVA-06** – The 6th International Conference on Intelligent Virtual Agents: http://iva2006.ict.usc.edu/

- **IJCAI-07** - International Joint Conference on Artificial Intelligence: http://www.ijcai-07.org/


- **ECAI-06** - The 17th European Conference on Artificial Intelligence: http://ecai2006.itc.it/

• Introduction
• Overview of Emotion
• Emotion in Learning
• Pedagogical Agents
• Conclusion

• References
References (1/4)

References (2/4)


References (3/4)


References (4/4)


Site:
Merriam-Webster Dictionary: http://www.m-w.com/