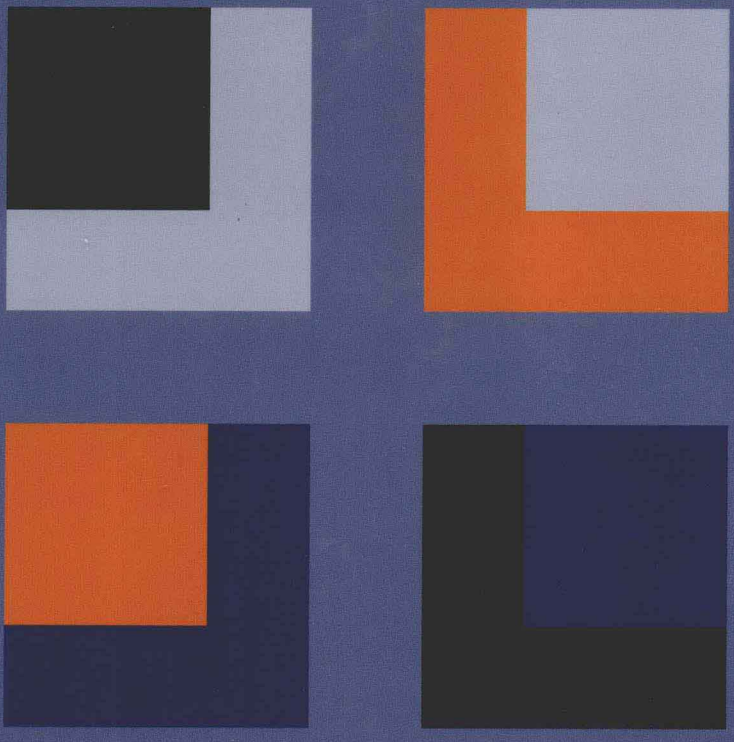
Animating Expressive Characters for Social Interaction

Edited by
Lola Cañamero and Ruth Aylett



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Animating Expressive Characters for Social Interaction

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To Fiorella de Rosis, *in memoriam*.
Her sharp mind, kindness, strength, high standards of commitment, as well as her support for interdisciplinary collaboration, new ideas and young researchers were a fundamental driving force in affective computing and other communities. Her memory will continue to be a source of inspiration for all of us.

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About the editors

Lola Cañamero (http://homepages.feis.herts.ac.uk/~comqlc) is Reader in Adaptive Systems at the School of Computer Science of the University of Hertfordshire (UH), United Kingdom, where has been faculty since 2001. She received a BA and MA in Philosophy from the Complutense University of Madrid, and a PhD in Computer Science (1995) from the University of Paris-XI. She worked as a post-doc in the group of Rodney Brooks at the MIT AI-Lab (1995–1996) and in the group of Luc Steels at the VUB AI-Lab (1997), and as senior researcher at the Spanish Scientific Research Council (1998–2000). Since 1995, her research has revolved around affect (motivation and emotion) modeling for autonomous and social agents/robots and adaptive behavior. At UH, she currently leads research on these topics and their intersections with other areas such as developmental and embodied robotics and human-robot interaction, focusing particularly on: embodied architectures based on motivations and emotions for decision-making in autonomous robots; motivation- and emotion-based learning of affordances; artificial evolution of affective systems; the role of affect in imitation; the development of affective bonds in robots and in simulated social groups; and expressive robotic heads for the study of emotion development and social interactions. She has organized over 14 international conferences and workshops in Europe and the USA since 1994, and acted as PC member of over 30 in these areas. She is author or co-author with her students over 80 refereed scientific papers, co-editor of the book *Socially Intelligent Agents: Creating relationships with computers and robots* (Kluwer Academic Publishers, 2002), guest editor (with Paolo Petta) of the special issue of *Cybernetics and Systems: An International Journal* "Grounding Emotions in Adaptive Systems" (2001), and of the special issue of the *International Journal of Humanoid Robotics* "Achieving Human-Like Qualities in Interactive Virtual and Physical Humanoids" (2006, with Catherine Pelachaud). She is member of the Editorial Board of the journal *Interaction Studies: Social Behaviour and Communication in Biological and Artificial Systems* (John Benjamins). She has been a full member of the International Society for Research on Emotion (ISRE) since 1999. Between January 2004 and December 2007, she coordinated the area "Emotion in Cognition and Action" of the EU-funded HUMAINE Network of Excellence (http://emotion-research.net), and since December 2006 she coordinates the also

EU-funded Advanced Robotics project FEELIX GROWING (http://www.feelix-growing.org) on socially situated emotional development.

Ruth Aylett (http://www.macs.hw.ac.uk/~ruth) has been a Professor of Computer Science at Heriot-Watt University In Edinburgh since 2004, where she leads the VIS&GE research group (Vision, Interactive Systems and Graphical Environments). This followed an initial job in the then British Computer industry of the late 1970s, and posts in Sheffield University, Sheffield Hallam University, University of Edinburgh and University of Salford.

Her research concerns the overlap of artificial intelligence and real-time interactive graphics, specifically affective agent architectures and interactive narrative. She has developed the idea of emergent narrative as an approach to solving the conflict between user freedom and narrative structure in interactive graphics environments and worked on believable characters able to sustain this approach. She has coordinated successive EU-funded projects since 2002 applying these ideas to a virtual drama system containing intelligent autonomous characters for educating against bullying behaviour in schools, and recently to education in intercultural empathy. Approaches to reconciling the psychology-based cognitive appraisal approach to affect with more neuro-physiological and somatic accounts are a long-term interest.

She is currently a partner in the EU project LIREC – Living with Robots and intEractive Characters – which is investigating how robots and graphical characters can become long-term companions to their human users. This includes work on long-term memory organised around auto-biographical episodes and indexed by emotional state. Other virtual character-based work includes a mobile guide 'with attitude' running on a hand-held device.

She has published more then 150 articles as book chapters, journal papers and refereed conference papers and taken part in a large number of international conference programme committees, most recently acting as a joint programme chair of ACII2007 and a senior programme committee member of AAMAS 2008. She was the initiator of the international conference Intelligent Virtual Agents (IVA). She has also published a popular science book *Robots: Bringing Intelligent Machines to Life?*

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* We regret that Professor Fiorella de Rosis, formerly of University of Bari in Italy, and Professor Kazuo Tanie, formerly of the National Institute of Advanced Science and Technology (AIST) in Japan, died before this book was published.

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Introduction

Lola Cañamero and Ruth Aylett

1. Motivation and background

The ability to express and recognize emotions is a fundamental aspect of social interaction. The importance of endowing artifacts (synthetic characters or robots) with these capabilities is nowadays widely acknowledged in different research areas such as affective computing, socially intelligent agents, computer animation, or virtual environments, and thus the interest in emotions and their expression spans very different disciplines. Expressing and recognizing emotions is studied in the social agent community because it is known to be fundamental to establishing a social relationship; it is studied in computer animation because it is also a basic requirement for the believability of animated characters and for human engagement in the narratives in which they are involved. It has also been studied for many hundreds of years in expressive arts and, for most of the 20thC and into the 21stC, in the psychology of emotion. With the growth of synthetic characters in virtual environments and on the web, as well as of the introduction of domestic or entertainment robots, this topic is also receiving an increased importance in various areas of computer science, artificial intelligence and related disciplines. However, these different communities study emotional expression and interactions in different ways and often do not interact with each other due, amongst other reasons, to the lack of appropriate platforms.

Even within computing, there is a gulf between graphics and animation researchers who are concerned about exterior expressiveness, and workers in AI and cognitive science who build computer models of the internals of such artifacts. Meanwhile communities entirely outside of computing have ideas known little or not at all within it but of major potential use, as witness the recent use of Laban analysis from dance choreography in behavioral animation. Researchers in all these areas are however confronted with the problem of how to make the emotional displays of artifacts and characters believable and acceptable to humans. This can involve not only generating appropriate expressions and behavioral displays – explored in animated film for many years – but also endowing artifacts

with underlying models of personality and emotions that support the coherence and autonomy of their emotional displays and interactions.

Our motivation behind this book and the AISB'02 symposium *Animating Expressive Characters for Social Interactions*,[1] from which the idea if this book arises, was to take a step towards bridging this gap, in two respects:

1. Multi-disciplinarity: Bringing together work from different disciplines (including psychology, the arts, computer graphics and animation, socially intelligent agents, synthetic characters, robotics, virtual reality, etc.) to reflect on this common problem from different perspectives and to gain new insights from this multi-disciplinary feedback.
2. "Animation" as unifying focus. Although different events and publications have explored isolated aspects of emotions and their expression in artificial agents (e.g., emotion-based architectures, models of personality, believability, interfaces, etc) and of animation in the sense this term has in the graphics community, to our knowledge no single event or publication has brought together the different aspects, models and techniques involved in designing and animating expressive characters for social interactions, from internal mechanisms to external displays. Our book concerns "animation" not only from a graphical perspective, but more generally in the human sense: making characters "life-like", externally but also "internally" – giving them an "anima", so that they appear as life-like entities and social partners to humans.

This book presents a multi-disciplinary collection of articles on various aspects (models and techniques) involved in animating (in the broad sense of the term mentioned above) synthetic and robotic expressive characters for social interactions. Its appropriateness for this particular series, Advances in Consciousness Research, lies in the interpersonal nature of human cognition, and the way in which relevant features and mechanisms used to "animate" artifacts externally or internally can be used to make them appear as life-like entities and social partners to humans. Expressive behavior is a basic element in the functioning of the 'Theory of Mind' that allows us to infer motivations, intentions and goals in other humans, and thus perhaps by extension in graphical and robotic agents and characters.

The intended readership is of a multi-disciplinary nature. This book does not require the reader to possess any specialist knowledge; it is suitable for any student or researcher with a general background in any of the fields informing the overall topic. It can also be used as a reference text / background reading for uni-

1. Information about the AISB'02 Symposium *Animating Expressive Characters for Social Interations* is available at http://homepages.feis.herts.ac.uk/~comqlc/aecsi02

versity courses in a number of topics, such as affective computing, animated and virtual agents, embodied artificial intelligence, animation techniques, etc.

2. Structure of the book and overview of the chapters

The book covers a wide variety of aspects (models and techniques) involved in "animating" (synthetic and robotic) expressive characters for social interactions. Although individual chapters span over various topics, the book can be organized around the following themes, each of them including contributions from different disciplines:

- The social nature of affective interactions: Chapters 1 and 2.
- Expression of emotions: Through the face (Chapters 3 and 4) and through the body (Chapters 5 and 6).
- Internal mechanisms for emotional expression and interaction: Chapters 7, 8 and 9.
- Expressive characters and robots as social partners: Social effects of affective artifacts: Chapters 10 and 11.
- Avatars – Embodying the human user in animated characters: Chapters 12, 13 and 14.
- Emotional interaction in fiction and drama: Chapters 15 and 16.

2.1 Social nature of affective interactions

In Chapter 1, "Social Emotions", Paul Dumouchel discusses an evolutionary basis for social emotions as a means of regulating interaction within groups of the same species, and assesses Darwin's seminal work in a modern context. He considers two different views of emotional expressiveness – one that sees it as a way of signaling an internal state, and a second that rather sees it as a definite action in its own right with communicative intent.

In Chapter 2, "Fabricating Fictions Using Social Role", Lynne Hall and Simon Oram emphasize the often disregarded fact that, like humans, embodied agents work within a culture and carry specific roles in particular situations. They argue that current technology is still far from producing cultural complexity convincingly, and their goal is to create agents that are aware of their social situation, and therefore capable of emitting signals that contextualize them in the world. To this end they have developed PACEO, a personal assistant that organizes meetings in a workplace context, as a tool to explore social interaction between the agent and human users. To build the agent, the approach they take is a pragmatic one, where

believability and user engagement are more important than the "intelligence" of the agent. To construct the agent's culture, they adopt a Foucauldian perspective to build a narrative of the social space of the agent, particularly concerning the roles that the notions of discourse, bio-power and workplace play in the narrative construction of culture.

2.2 Expression of emotions through the face and the body

Chapter 3, "What's in a Robot's Smile? The Many Meanings of Positive Facial Display" by Marianne LaFrance offers a valuable corrective to simplistic accounts of the relationship between facial expression and affective state by discussing the example of smiling. LaFrance shows that smiles appear in a variety of forms in order to express a variety of emotions, with only one, the Duchenne smile, unambiguously associated with happiness. Smiles (and other emotion-related facial displays) are not necessarily indicators of internal states, but often act as social messages, e.g. to show others our disposition towards an interaction episode. From the perspective of smiles as volitional social messages, the problem of distinguishing "true" from "fake" smiles holds less relevance than it has traditionally been given. Instead, understanding the meaning of a smile requires understanding the social context in which that smile occurs, and this chapter examines some of the social dimensions that are related to different types of smiles.

In Chapter 4, "Facial Expressions in Social Interactions: Beyond Basic Emotions", Susanne Kaiser and Thomas Wehrle illustrate how an appraisal-based approach to understanding the relation between emotion and facial expression can be instrumental to multidisciplinary research that brings together emotion theory and computational modeling, encompassing aspects of facial expression synthesis, automatic expression recognition, and artificial emotions. Going beyond the study of emotions in classical experimental settings, these authors use human-computer interaction, in particular interactive computer games, to study the dynamics of ongoing cognitive and emotional episodes in what they call *emotional problem solving*. In addition to a theoretical model based on a component process approach, Kaiser and Wehrle propose a set of computer tools to perform both, analysis and synthesis of facial emotional expressions using situated coding procedures, and to test predictions arising from the model.

Chapter 5, "Expressing Emotion Through Body Movement: A Component Process Approach", by Marc Coulson, also takes an appraisal-based, componential approach to the study of emotional expression closely related to that of Kaiser and Wehrle, but this time applied to the study of emotional expression through the body. Contrary to facial emotional expression, systematic studies of bodily

emotional expression are very rare; Coulson identifies a number of reasons for this, such as the greater weight of other bodily functions such as locomotion and manipulation, the higher individual and cultural variation in expression and recognition of emotions through the body, and the higher complexity of the body in terms of degrees of freedom, movements, and postures. The use of a computer simulation of a human body allows Coulson to model a number of functionally significant postures resulting from the outcomes of Stimulus Evaluation Checks, providing a starting point to test not only the quality of the modeling but also of the component process model.

Chapter 6, "Affective Bodies for Affective Interactions" by Marco Vala, Ana Paiva, and Mário Rui Gomes examines the issue of expressive behavior in 3D graphical characters in motion. The authors explore a computer graphics approach in which the posture and stance required for an action can be modified by the affective state of the character to produce expressive behavior in real time. This approach combines neutral animations, stance composition and changes in the speed and amplitude of the animation to create different affective scripts , and can be used in different characters from both humanoid and non-humanoid skeletons. Examples of such scripts are provided in the context of the computer game FantasyA, a magic duel in which characters fight each other using spells. Unlike other computer games, the user does not decide which magic spell to use but influences the emotional state of the character, and this chooses spells autonomously. To be able to play, the user must thus recognize the emotional states of the characters.

2.3 Internal mechanisms for emotional expression and interaction

Chapter 7, "Animating Affective Robots for Social Interaction" by Lola Cañamero, considers what artificial emotions can contribute to social interactions between robots and humans. Cañamero argues for a deep, rather than a shallow, emotion system that is grounded into the internal architecture of social robots. She examines both individual and social grounding, including the issues surrounding embodiment , the autobiographic self, and the theory of mind.

Chapter 8, "Dynamic Models of Multiple Emotion Activation" by Valeria Carofiglio, Fiorella de Rosis and Roberto Grassano, applies Dynamic Belief Networks to the problem of an agent "feeling" multiple emotions simultaneously. Such formalism has been chosen to permit the representation of the two main mechanisms by which several emotions that are simultaneously active might interact – they might coexist and mix, or they might switch between each other in rapid succession. The starting hypothesis of this chapter is that emotions are activated by the belief that