Preface

Only thirty years ago, the field of emotion research was an almost uncharted territory: an almost desert island very few people were interested in visiting and even less were interested in staying. Neuroscientists consider the frontal lobes mostly a source of conflict from people with mental diseases, so the prescription of lobotomies was quite common; emotions were, for cognitive psychologists, just a source of irrationality, so nobody did paid much attention to them. If you randomly picked up three different books of introduction to cognitive psychology, they would give you three different lists of emotional states: the first book would include hunger and sexual desire as emotions, but wouldn't include surprise. The second book included surprise and sexual desire but consider hunger just a "drive", and the third included a list of forty different emotions, most of them not mentioned in the first two. And, if the AI people were interested at all in emotions that was probably just as a trick to feign emotions in a computer in order to help it to pass a future Turing Test.

Fortunately, these perceptions have changed dramatically since then, and now the study of emotions is a very active and respected field. This change of perception is mainly due to changes in methodology and new experimental results from those three main disciplines we were just discussing.

1. Neuroscience has supplied lots of empirical data as well as some functioning models on the key role that emotion plays when we humans make decisions. Since the studies of the patient—now almost a legend—Phineas Gage we have come to realise that emotions, far from being a nuisance, are not a dissociable part of most of our mental states, playing a role both in cognition and perception.
2. The evolution by means of procuring better and more detailed models, as well as the collection of empirical confirmation from very different sources has turned the cognitive model of emotions from a curiosity to the more accepted and influencing model of what emotions are now. This has helped greatly in introducing the concept of emotion into several research fields of cognitive psychology from which it was missing.
3. The development of affective computing has proved to be a very valuable field in AI, offering new interacting and theoretical models on what it means to be "intelligent" and how important emotions are in improving communications between humans and computers. At the same time, bottom-up approaches for the creation of autonomous artificial creatures include more and more emotional elements to their prototypes.

All these promising results as well as the emerging paradigm of affective computing have motivated us to produce this volume on synthetic emotions and social robots which you are reading now. We strongly believe that research in this field is important to developing better computer applications which are more able to communicate with humans or fulfill their tasks. We also argue that synthetic emotions can help not only neuroscience or cognitive psychology test their models "in silicon"; we can gain a lot much more from this research. It can take the form of interdisciplinary models for relationships between emotions

and cognition and it can even lead us to rethink classical philosophical problems, like the question of the reality of *qualia* and consider "the hard problem of consciousness" from another point of view.

We have divided the book into the following sections, which we consider the more promising now in this field: recognizing emotions, emotional social robots, philosophical questions, modelling emotions, applied artificial emotions and ambient emotion.

SECTION I. RECOGNIZING EMOTIONS

This section includes state of the art chapters on how we can create artificial systems to recognize emotional states in humans and use them to interact better with them, or to make predictions on groups' behavior.

In "*Emotional Modeling in an Interactive Robotic Head*," Oscar Deniz, Javier Lorenzo, Mario Hernández, Modesto Castrillón, and Gloria Bueno, describes the emotional model and implementation of CASIMIRO, a prototype social robot built by the authors. CASIMIRO is a complex robot with multimodal capabilities defined by a number of software modules, a social robot able to recognize emotions.

"*Automatic Detection of Emotions in Music: Interaction with Emotionally Sensitive Machines*" presents the work from Cyril Laurier and Perfecto Herrera in order to detect emotion in music from audio content, describing a machine learning method to do so.

This section ends with chapter "*Facial Expression Analysis, Modeling and Synthesis: Overcoming the Limitations of Artificial Intelligence with the Art of the Soluble*" by Christopher Bartneck and Michael J. Lyons, which reviews the situation in HCI with regard to the human face, and discusses strategies, which could bring more slowly developing areas up to speed.

SECTION II. EMOTIONAL SOCIAL ROBOTS

This section contains a description of methodologies, developments and theories on how to use artificial emotions in order to facilitate the development of social robots; autonomous artificial systems which are able to cooperate among them in order to fulfill specific tasks.

"*Multirobot Team Work with Benevolent Characters: The Roles of Emotions*" by Sajal Banik, Keigo Watanabe, Maki K. Habib, and Kiyotaka Izumi, describes an emotional model and strategy in order to make cooperative robots to work between there better, including the concept of "benevolent character" in the modelling, while "*Affective Goal and Task Selection for Social Robots*" written by Matthias Scheutz and Paul Schemerhorn presents a DIARC or distributed integrated affect cognition and reflection architecture designed to help social robots make decisions.

Authors Christopher P. Lee-Johson and Dale A. Carnegie present "*Robotic Emotions: Navigation with Feeling*" which describes a mobile robot navigation system that employs affect and emotion as adaptation mechanisms. The robot's emotions can arise from hard-coded interpretations of local stimuli, as well as from learned associations stored in global maps.

SECTION III. PHILOSOPHICAL QUESTIONS

Following the X-Phi or Experimental Philosophy paradigm, this section is devoted to show how classical and recent philosophical conundrums can be shed new light on the artificial emotions field.

According to C. Gros, in "*Emotions, Diffusive Emotional Control and the Motivational Problem for Autonomous Cognitive Systems*," intelligent systems need to include motivational procedures, showing therefore the importance of emotional control for the design of artificial intelligences and synthetic cognitive systems.

"*Robots React, but Can They Feel*?" allows author Bruce J. MacLennan to analyse the famous "hard problem of consciousness" within the context of synthetic emotions, trying to understand whether it is possible to consider a robot able to feel them.

The chapter "*Personality and Emotions in Robotics from the Gender Perspective*" by Mercedes García-Ordaz, Rocío Carrasco-Carrasco, and Francisco Martínez-López seeks to apply the gender perspective in the analysis of some emotional features to be taken into account before they are applied to the field of robotics.

Antoni Gomila and Alberto Amengual presents in "*Moral Emotions for Autonomous Agents*" the moral implications related to the idea of an autonomous robot and how to deal with the nightmare of the "evil robot" that loses control.

SECTION IV. MODELLING EMOTIONS

Besides being useful to solve or improve certain tasks within the AI domain, artificial emotions are also an important instrument for simulating emotional processes and developing better models of what an emotion is, which can be of great help for several cognitive science disciplines.

"*An Emotional Perspective for Agent-Based Computational Economics*" by Pietro Cipresso, Jean-Marie Dembele, and Marco Villamira, presents an analytical model of hyper-inflated economies and develops a computational model that permits us to consider expectations of the levels of future prices following emotional rules and strategies.

Michel Aubé shows us in "*Unfolding Commitments Management: A Systemic View of Emotions*" a model of emotion which is more realistic that the usual ones, in order to develop artificial emotional applications that are really functional.

In "*A Cognitive Appraisal Based Approach for Emotional Representation*," Sigerist J. Rodríguez, Pilar Herrero, and Olinto J. Rodríguez presents a model for synthetic emotions based on the cognition/appraisal theory, while Clément Raïevsky and François Michaud present the usefulness of the signaling function of emotion for situated agents and an artificial model of anger and fear based on mismatch theories of emotion in their chapter "*Emotion Generation Based on a Mismatch Theory of Emotions for Situated Agents*."

Luis Macedo, Amilcar Cardoso, Rainer Reisenzein, Emiliano Lorini, and Cristiano Castelfranchi, presents in "*Artificial Surprise*" a review of the models of surprise, compares several of them, and indicates future research and possible practical applications. Based on Arabic word roots, author Tom Adi describes a linguistically based theory of emotions in "*A Theory of Emotions Based on Natural Language Semantics*."

SECTION V. APPLIED ARTIFICIAL EMOTIONS

Recently, we have seen an important increase in the use of emotion to help computers to solve simple tasks: from passing the Turing Test to create more friendly and useful learning environments, as we can see from the materials of this section.

In their chapter "Emotion in the Turning Test: A Downward Trend for Machines in Recent Loebner Prizes," Huma Shah and Kevin Warwick argue how important is to include some ability to use and recognize emotions if we want an AI to pass the Turing test. In "*The Use of Artificial Emoitional Intelligence in Virtual Creatures*" by Félix Ramos, Héctor Rafael Orozco Aguirre, and Luis Alfonso Razo Ruvalcaba, the authors argue the importance of emotions in order to design a proper avatar in order to model its perception, learning, decision process, behavior and other cognitive functions.

The chapter by Sarantos I. Psycharis, "*Physics and Cognitive-Emotional-Metacognitive Variables-Learning Performance in the Environment of CTAT*," applies artificial emotion to teach mechanics, while authors Anthony G. Francis Jr., Manish Mehta, and Ashwin Ram in the chapter "*Emotional Memory and Adaptive Personalities*", presents an artificial intelligence model inspired by these psychological results in which an emotion model triggers case-based emotional preference learning and behavioral adaptation guided by personality models. Finally, in the chapter "*Computer-Based Learning Environments with Emotional Agents*" authored by Dorel Gorga and Daniel K. Schneider discusses conceptual issues and challenges related to the integration of emotional agents in the design of computer-based learning environments and proposes a framework for the discussion of future research.

SECTION VI. AMBIENT EMOTION

Both from a theoretical and practical point of view, the field of Ambient Intelligence— or how to include some sort of intelligent ability to interact with humans and solve specific tasks in a distributed system—can gain a lot by means of including artificial emotions in their modeling. Here we explain how this can be done.

In "*Emotional Ambient Media*," Artur Lugmayr, Tillmann Dorsch, and Pabo Roman Humanes, introduces the reader to a technical oriented view towards recognizing, simulating, and binding emotions in ambient media systems, as well as presenting a case study for an emotion recognition and response system. "*Modelling Hardwired Synthetic Emotions: TPR 2.0*" by the editors of this book describes an ambient intelligence system which uses protoemotions in order to respond to specific actions from the user. The book ends with "*Invisibility and Visibility: The Shadows of Artificial Intelligence*" by Cecile K. M. Crutzen and Hans-Werner Hein which analyses how the mental, physical, and methodical invisibility of artificial intelligent tools and environments will have an effect on the relation between the activities of both users and designers.

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