

## Introduction: A Guided Tour to the Handbook of Affective Computing

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As we write this Introduction, Affective Computing (AC) is about to turn 18. Though relatively young, but entering the age of maturity, AC is a blossoming multidisciplinary field encompassing computer science, engineering, psychology, education, neuroscience, and many other disciplines. AC research is diverse indeed. It ranges from theories on how affective factors influence interactions between humans and technology, on how affect sensing and affect generation techniques can inform our understanding of human affect, and on the design, implementation and evaluation of systems that intricately involve affect at their core.

The 2010 launch of the *IEEE Transactions on Affective Computing* (IEEE TAC), the flagship journal of the field, is indicative of the burgeoning research and promise of AC. The recent release of a number of excellent books on AC, each focusing on one or more topics, is further evidence that AC research is gradually maturing. Furthermore, quite different from being solely an academic endeavor, AC is being manifested in new products, patent applications, start-up companies, university courses, and new funding programs from agencies around the world. Taken together, interest and excitement in AC continues to flourish since its launch almost two decades ago.

Despite its recent progress and bright future, what the field is missing, is a comprehensive handbook that can serve as the go-to reference for AC research, teaching, and practice. This Handbook aspires to achieve this goal. It was motivated by the realization that both new and veteran researchers needed a comprehensive reference book that discusses the basic theoretical underpinnings of AC, its bread and butter research topics, methodologies to conduct AC research, and forward looking applications of AC systems. In line with this, the *Handbook of Affective Computing* aims to help both new and experienced researchers identify trends, concepts, methodologies, and applications in this exciting research field. The Handbook aims to be a coherent compendium, with chapters being authored by world leaders in each area. In addition to being the definitive reference for AC, the handbook will also be suitable for use as a textbook for an undergraduate or graduate course in AC. In essence, our hope is that the Handbook will serve as an invaluable resource for AC students, researchers, and practitioners worldwide.

The Handbook features 41 chapters including this one, and is divided into five key main sections: history and theory, detection, generation, methodologies, and applications. Section 1 begins with a look at the makings of AC and a historical review of the science of emotion. These are followed by chapters discussing the *theoretical underpinnings* of AC from an interdisciplinary perspective encompassing the affective, cognitive, social, media, and brain sciences. Section 2 focuses on *affect detection* or affect recognition, which is one of the most commonly investigated areas in AC. Chapters in this section discuss affect detection from facial features, speech (paralinguistic), language (linguistics), body language, physiology, posture, contextual features, and multimodal combinations of these modalities. Chapters in Section 3 focus on aspects of *affect generation* including the synthesis of emotion and its expression via facial features, speech, postures and gestures. Cultural issues in affect generation are also discussed. Section 4 takes a different turn and features chapters that discuss *methodological*

*issues* in AC research including data collection techniques, multimodal affect databases, emotion representation formats, crowdsourcing techniques, machine learning approaches, affect elicitation techniques, useful AC tools, and ethical issues in AC. Finally, Section 5 completes the Handbook by highlighting existing and future *applications* of AC in domains such as formal and informal learning, games, robotics, virtual reality, autism research, healthcare, cyberpsychology, music, deception, reflective writing, and cyberpsychology.

## **Section 1: History and Theory**

AC is a scientific and an engineering endeavor that is both inspired by and also inspires theories from a number of related areas such as psychology, neuroscience, computer science, linguistics, etc. In addition to providing a short history of the field, the aim of Section 1 is to describe the major theoretical foundations of AC and attempt to coherently connect these different perspectives.

This section begins with a chapter by Rosalind Picard, the field's distinguished pioneer who also coined its name. Chapter 2 is an adaptation of an introductory paper that was published in the inaugural issue of *IEEE Transactions on Affective Computing*. Picard's chapter, *The promise of Affective Computing*, provides an outline of AC's history and its major goals. Picard shares stories, sometimes personal, and offers historical perspectives and reflections of the birth and evolution of the AC community over the past 18 years.

The field's 18th birthday is a celebration of Picard's seminal book, *Affective Computing*, published in 1997, yet the study of emotions as a scientific endeavor dates back to the 19<sup>th</sup> century with pioneers like Bell, Duchenne, and Darwin. Although it is daunting to provide a meaningful history of such an entrenched topic in a single chapter, Rainer Reisenzein does an excellent job in his chapter: *A short history of psychological perspectives on emotion* (Chapter 3). The chapter reviews various psychological perspectives on emotions that have emerged over the last century and beyond with respect to five key questions: (1) how are emotions generated?; (2) how do they influence cognition and behavior?; (3) what is the nature of emotions?; (4) how has the emotion system evolved?; and (5) what are the brain structures and processes involved in emotions?

It is clear that neuroscience is strongly influencing the way we think about affective phenomena, a trend that is only likely to increase in the coming years. In Chapter 4, *Neuroscientific perspectives of emotion*, Andrew Kemp, Jonathan Krygier, and Eddie Harmon-Jones summarize the exponentially growing affective neuroscientific literature in a way that is meaningful to the technically-driven AC community. They discuss the neurobiological basis of fear, anger, disgust, happiness and sadness; 'the basic' emotions still used in much of AC research. Their chapter expands on the current debate as to whether these basic emotions are innate or whether more fundamental neuropsychobiological processes interact to produce these emotions. The 'embodied cognition' perspective they adopt has received increased attention in cognitive psychology and Human-Computer Interaction (HCI) literatures and might be beneficial to AC research as well.

Informed by all this science, engineers need concrete ways to represent emotions in computer systems and appraisal theories provide one of the more promising representational structure to advance this goal. These are discussed in Chapter 5, entitled *Appraisal models*, by Jonathan

Gratch and Stacy Marsella. The appraisal theory of emotions has been the most widely adopted theory in affective computing. It is well suited for computing research because it provides a structured representation of relationships between a person and the environment, the different appraisal variables, and other components of the information processing ensemble that is needed to model emotions.

Interpersonal information (information relevant to social interactions) play a critical role in affective human-human interactions, but the dynamics of this information might change during human-computer interactions. Understanding the complexity of pertinent issues, such as how new media can best communicate social cues, is essential in a world where a significant portion of interpersonal communication is done through 'emotionally challenged' media such as email and social networks. The design of such systems will often incur tradeoffs, and these should be informed by a careful analysis of the advantages and disadvantages of different forms of mediated communication.. These and other related issues are given a detailed treatment in Chapter 6 by Brian Parkinson: *Emotions in interpersonal life: Computer mediation, modeling, and simulation*.

Maja Pantic and Alessandro Vinciarelli introduce the wider field of *Social signal processing* in Chapter 7. This area is closely related to AC in that it seeks to combine social science research (for understanding and modeling social interactions) with research in computer science and engineering that is aimed at developing computers with similar abilities.

There are many reasons for building AC systems, some of which involve the basic scientific goal of understanding psychological phenomena while others are more practical, such as building better software systems. These motivations influence the type of architectures used. In *Why and how to build emotion-based agent architecture* (Chapter 8), Christine Lisetti and Eva Hudlicka, review some of the emotion theories and discuss how they are used for creating artificial agents that can adapt to users' affect.

The motivations and the type of questions researchers ask is also, at least partially, linked to society's perceptions of what computers could and should do, perceptions often reflected in the popular media. In line with this, the first section of the Handbook concludes with Despina Kakoudaki's discussion of *Affect and machines in the media* (Chapter 9), i.e. how artificial entities (e.g. computers) that have affective qualities have been portrayed in the media across time and how these portrayals have influenced AC research.

## **Section 2 (Affect Detection)**

The development of an affect-aware system that senses and responds to an individual's affective states generally requires the system to first detect affect. Affect detection is an extremely challenging endeavor due to the numerous complexities associated with experience and expression of affect. Chapters in Section 2 describe several ingenious approaches to this problem.

Facial expressions are perhaps the most natural way that humans express emotions, so it is fitting to begin Section 2 with a description of facial-expression based affect detection. In, *Automated face analysis for affective computing* (Chapter 10), Jeff Cohn and Fernando De la Torre discuss how computer vision techniques can be informed by human approaches to measure and code

facial behavior. Recent advances in face detection and tracking, registration, extraction (of geometric, appearance and motion features), and supervised learning techniques are discussed. The chapter completes its introduction to the topic with a description of applications such as physical pain assessment and management, detection of psychological distress, depression, and deception, and studies on interpersonal coordination.

Technologies that capture both fine and coarse grained body movements are becoming ubiquitous due to low cost and easy integration in real-world applications. For example, Microsoft's Kinect camera has made it possible for non-experts in computer vision to include the detection of gait or gestures like knocking, touching and dancing in applications ranging from games to learning technologies. In *Automatic recognition of affective body expressions* (Chapter 11), Nadia Bianchi-Berthouze and Andrea Kleinsmith discuss the state of the art in this field including devices to capture body movements, factors associated with perception of affect from these movements, automatic affect recognition systems, and current and potential applications of such systems.

Speech is perhaps the hallmark of human-human communication and it is widely acknowledged that *how* something is said (i.e., paralinguistics) is as important as *what* is being said (linguistics). The former is discussed by Chi-Chun Lee, Jangwon Kim, Angeliki Metallinou, Carlos Busso, Sungbok Lee, and Shrikanth S. Narayanan in Chapter 12, *Speech in Affective Computing*. This chapter starts with the fundamental issue of understanding how expressive speech is produced by the vocal organs, followed by the process of extracting acoustic-prosodic features from the speech signal, thereby leading to the development of speech-based affect detectors.

Affect detection from language, sometimes called sentiment analysis, is discussed in Chapter 13 by Carlo Strapparava and Rada Mihalcea entitled *Affect detection in texts*. They begin with a description of lexical resources that can be leveraged in affective natural language processing tasks. Next, they introduce state-of-the-art knowledge-based and corpus-based methods for detecting affect from text. They conclude their chapter with two very intriguing applications: humor recognition and a study on how extra-linguistic features (e.g. music) can be used for affect detection.

Since antiquity, eastern and western philosophers have speculated about how emotions are reflected in our bodies. At the end of the 19th century, William James and Charles Darwin studied the relationship between the autonomic nervous system and emotions. More recently, with the introduction of accurate, small, portable and low cost sensors, physiological-based affect detection has dramatically exploded. Physiological researchers usually make a distinction between central and peripheral physiological signals (brain vs. body). Affect detection from peripheral physiology is discussed by Jennifer Healey in *Physiological sensing of affect*. This chapter provides a brief history into the psychophysiology of affect followed by a very accessible introduction to physiological sensors, measures, and features that can be exploited for affect detection.

Applications that monitor central physiology are discussed by Christian Mühl, Dirk Heylen, Anton Nijholt in the context of *Affective Brain-Computer interfaces: Neuroscientific approaches to affect detection* (Chapter 15). Their chapter reviews the theory underlying neuropsychological

approaches for affect detection along with a discussion of some of the technical aspects of these approaches with an emphasis on electrophysiological (EEG) signals. Major challenges and some imaginative potential applications are also discussed.

It is difficult to introduce sensors in the physical environment in some interaction contexts, such as classrooms. In these situations, researchers can infer affect from the unfolding interaction between the software and the user. In Chapter 16, *Interaction-based affect detection in educational software*, Ryan Baker and Jaclyn Ocumpaugh describe pioneering research in this field, particularly in the context of intelligent tutoring systems and educational games. In addition to reviewing the state of the art, their discussion on methodological considerations, such as ground truth measures, feature engineering, and detector validation, will be useful to researchers in other application domains as well.

The aforementioned chapters in this section described research in one of the many modalities that can be used for affect detection. However, human communication is inherently multimodal, so it is informative to consider multimodal approaches to affect detection. A review of this literature with an emphasis on key issues, methods, and case studies is presented in Chapter 17 entitled, *Multimodal affect detection for naturalistic human-computer and human-robot interactions*, by Ginevra Castellano, Hatice Gunes, Christopher Paters, and Björn Schuller.

### **Section 3 (Affect Generation)**

Section 3 of the Handbook focuses on another important step toward building affect-aware systems -affect generation. More specifically, chapters in this section focus on embodied conversational agents (ECAs) (e.g., animated agents, virtual characters, avatars) that generate synthetic emotions and express them via nonverbal behaviors.

ECAs can have increasingly expressive faces in order to enhance the range of human-computer interaction. In Chapter 18, *Facial expressions of emotions for virtual characters*, Magalie Ochs, Radoslaw Niewiadomski, and Catherine Pelachaud discuss how researchers are developing ECAs that are capable of generating a gamut of facial expressions that convey emotions. One of the key challenges in this field is the development of a lexicon linking morphological and dynamic facial features to emotions that need to be expressed. The chapter introduces the methodologies used to identify these morphological and dynamic features. It also discusses the methods that can be used measure the relationship between an ECA's emotional expressions and the user's perception of the interaction.

ECAs, just like humans can be endowed with a complete body that moves and expresses emotions through its gestures. Margaux Lhommet and Stacy Marsella in *Emotion postures and gestures* (Chapter 19) discuss many of the issues in this line of research. The bodily expressions can be produced via static displays or with movement. New techniques for emotional expressions in ECAs need to be represented in ways that can be used more widely. This is done using markup languages, some of which are briefly described in this chapter as well as in the chapter by Ochs and colleagues. Markup languages require a more extensive coverage so we have included a chapter on this topic in the next section.

Software agents are increasingly common in applications ranging from marketing to education. Possibly the most commonly used agents communicate over the phone with natural language processing capabilities. Consider Siri, Apple's virtual assistant, or the Automated Response Units that preceded it by providing automated voice-based booking for taxis and other services over the phone. The future of these systems will require the agents to replace the current monotone speech syntheses with *Emotional speech synthesis* (Chapter 20) as described by Felix Burkhardt and Nick Campbell. In this chapter, the authors provide a general architecture for emotional speech synthesis, discuss basic modeling and technical approaches, followed by use cases and potential applications.

ECAs may have virtual faces and bodies, but they are still software instantiations and therefore implement a limited sense of "embodiment". One way of addressing this limitation is through physicality of robots, and Ana Paiva, Iolanda Leite and Tiago Ribeiro describe this research in their chapter entitled *Emotion modeling for social robots* (Chapter 21). They begin by describing the affective loop (Höök, 2009), where the user first expresses an emotion and then the system responds by expressing an appropriate emotional response. These responses convey the illusion of a robotic life, and demonstrate how even simple behaviours can convey emotions

The final chapter of Section 3, *Preparing emotional agents for intercultural communication* (Chapter 22), by Elisabeth André, addresses the challenge of how agents and robots be designed to communicate with humans from different cultural and social backgrounds. It is already difficult to scaffold human-human communication when there are intercultural differences among communicators. The challenge is even more significant for human-computer communication. We need to understand how emotions are expressed across cultures and improve our emotion detection and generation techniques by either fine-tuning them to particular cultures or by generalizing across cultures (to the extent possible). This chapter provides an overview of some of the research in this area and touches on several critical topics such as culturally-aware models of appraisal and coping and culture-specific variations of emotional behaviors.

#### **Section 4 (Affective Computing Methodologies)**

Although AC utilizes existing methods from standing fields including the affective sciences, machine learning, computer vision, psychophysiology, and so on, it adapts these techniques to its unique needs. This section presents many of these "new" methodologies that are being used by AC researchers to develop interfaces and techniques to make affect compute.

The problem of how to best collect and annotate affective data can be structured in a number of stages. Björn Schuller proposes ten stages in the opening chapter of this section entitled *Multimodal affect databases – Collection, challenges & chances*. The chapter discusses the challenges of collecting and annotating affective data, particularly when more than one sensor or modality is used. Schuller provides ten steps that highlight the most important considerations and challenges including: 1) ethical issues; 2) recording and reusing; 3) meta-information; 4) synchronizing streams; 5) modelling; 6) labeling; 7) standardizing; 8) partitioning; 9) verifying perception and baseline results and 10) releasing the data to the wider community. The chapter also provides a selection of representative audio-visual and other multimodal databases. We have covered these considerations with different depth across a number of chapters in the Handbook.

Some of these steps are encompassed in multiple chapters, while some chapters address multiple steps. For example, approaches to managing meta-information are discussed in Chapter 29, and Schuller himself discusses the challenges related to synchronizing multimodal data streams.

The first of Schuller's steps towards collecting affective data involves addressing ethical issues, a topic where formal training for engineers is sometimes scarce. In his chapter, *Ethical issues in affective computing* (Chapter 24), Roddie Cowie brings together fundamental issues such as the formal and informal codes of ethics that provide the underpinning for ethical decisions. Practical issues have to do with the enforcement of the codes and ethical principles, which falls under the purview of Human Research Ethics Committees. The chapter will help understand issues that these committees are concerned about, such as informed consent, privacy, and many more.

The second step to building an affective database, according to Schuller, is to make decisions about collecting new data or reusing existing affective databases. This involves deciding on the tools to be used, some of these are discussed in *Research and development tools in affective computing* (Chapter 25), by Sazzad Md Hussain, Sidney D'Mello, and Rafael A. Calvo. The most common tools were identified by surveying current AC researchers, including several authors of this Handbook, and therefore are a reflection of what researchers in the field find useful. Readers can find out about available databases in Schuller's chapter and at [emotion-research.net](http://emotion-research.net).

Other issues to be taken into account include decisions on the affect representation model (fifth step according to Schuller, e.g. continuous or categorical) and temporal unit of analysis. Several chapters in this section briefly discuss issues that need to be considered when making these decisions, but the topic warranted its own chapter. In *Emotion data collection and its implications for affective computing* (Chapter 26), Shazia Afzal and Peter Robinson discuss naturalistic collection of affective data while people interact with technology and propose new ways of studying affective phenomena in HCI. They emphasize issues that arise when researcher try to formalize their intuitive understanding of emotion into more formal computational models.

Another related chapter (27), *Affect elicitation for affective computing*, by Jacqueline Kory and Sidney D'Mello, discusses ways to reliably elicit emotions in the lab or "in the wild" (i.e. real world situations). Kory and D'Mello discuss both passive methods such as video clips, music or other stimuli and active methods that involve engaging participants in interactions with other people or where they are asked to enact certain behaviours, postures or facial expressions. Examples of how these methods have been used by AC researchers are also discussed.

One of the most time consuming and expensive stages of developing an affective database is affect labeling or annotation. Often this task can be outsourced to a large number of loosely coordinated individuals, often at a much lower cost, and much faster turnaround time. This process called crowdsourcing is discussed in the context of AC by Robert R. Morris and Daniel McDuff in chapter 28 *Crowdsourcing techniques for affective computing*. Crowdsourcing already has garnered impressive success stories as when millions of images were labeled by people playing the ESP Game while working for free and even having fun. Hence, researchers planning to follow this approach will benefit from Morris and McDuff's account of the

development and quality assurance processes involved in affective crowdsourcing.

Schuller's seventh consideration, standardizing, is about seeking compatibility in the data and the annotations, so the data can be used across systems and research groups. In Chapter 29 entitled, *Emotion markup language*, Marc Schröder, Paolo Baggia, Felix Burkhardt, Catherine Pelachaud, Christian Peter, and Enrico Zovato discuss EmotionML, the markup language for AC recommended by the World Wide Web Consortium (W3C). EmotionML is designed for representing and communicating affective representations across a series of use cases that cover several types of applications. It provides a coding language based on different emotion theories, so emotions can be represented by four types of data: categories, dimensions, appraisals, and action tendencies. Using these four types of data <emotion> events can be coded as a data structure that can be implemented in software and shared.

Affect detection algorithms generally use supervised machine learning techniques that use annotated data for training. As Ashish Kapoor explains in Chapter (30), *Machine learning techniques in Affective Computing*, when considered in tandem, labeling and training of algorithms can be optimized using active information acquisition approaches. Other approaches to annotation, feature extraction and training that take into account how the data will be used in machine learning, are also discussed by Kapoor.

## **Section 5 (Affective Computing Applications)**

One of the key goals of AC is to develop concrete applications that expand the bandwidth of human-machine interaction via affective or emotional design. In line with this, this section highlights existing and emerging applications from a range of domains but with an emphasis of affect at their core.

Learning technologies abound in the digital and physical (e.g. school) spaces and have been one of the first AC applications. A prolific research community, known as Intelligent Tutoring Systems and Artificial Intelligence in Education, has focused on developing next-generation learning technologies that model affect in addition to cognition, meta-cognition, and motivation. Sidney D'Mello and Art Graesser present a summary of these technologies in *Feeling, thinking and computing with affect-aware learning technologies* (Chapter 31). They provide examples of two types of affect-aware educational technologies: reactive systems that respond when affective states are detected and proactive systems that promote or reduce the likelihood of occurrence of certain affective states.

The case studies described in D'Mello and Graesser's chapter focuses on learning technologies that support school-related formal learning. However, learning is a lifelong endeavor and much of learning occurs outside of formal educational settings including museums, science centers, and zoos. These informal learning environments can also benefit from affect-aware technologies. In *Enhancing informal learning experiences with affect-aware technologies* (Chapter 32), Chad Lane describe how these technologies can be used to promote interest and attitudes in addition to knowledge when visitors engage in informal learning contexts.

Writing is perhaps the quintessential 21<sup>st</sup> century skill and both academic and professional work involve considerable writing. Changes in our writing environments brought about by the



information age alter the writing process itself. On the positive side, we have access to endless resources and collaboration opportunities than ever before. Yet, on the other hand, there are new problems and distractions, such as a continual barrage of email, social media, and countless other distractions of the digital age. In Chapter 33, entitled *Affect-aware reflective writing studios*, Rafael A. Calvo explores how new technologies can be used to produce tools that writers can use to reflect on the process they adopt, including circumstances in which they are most productive or enjoy writing the most.

Not everything in life can be learning and work. Georgios N. Yannakakis and Ana Paiva discuss how AC can improve gaming experiences (both for entertainment and learning) in *Emotion in Games* (Chapter 34). They review key studies on the intersection between affect, game design, and technology and discuss how to engineer effective affect-based gaming interactions.

Referring to another form of entertainment, music, Egon van den Broek, Joyce Westerink, and Joris Janssen discuss affect-focused music adaptation in Chapter 35, *Autonomous closed-loop biofeedback: An introduction and a melodious application*. The chapter starts by considering some of the key issues involved in engineering closed-loop affective biofeedback systems and applies these insights towards the development and real-world validation of an Affective Music Player.

The two previous chapters have discussed how education and entertainment could be improved with AC techniques. The following chapters focus on applications where the users interact and collaborate with robots or other humans. In *Affect in human robot interaction* (Chapter 36), Ronald Arkin and Lilia Moshkina discuss various issues involved in this endeavor. They also pose some fundamental research questions such as, how can affect-aware robotics add value (or risks) to human-robot interactions?; whether such robots can become companions or friends?; what is the role of embodiment in affective robotics, i.e., do the robots need to experience emotions to be able to express them and what theories and methods can inform affective Human-Robot Interaction (HRI) research?

The next two chapters focus on human-human interactions. First, Jakki Bailey and Jeremy Bailenson discuss how collaborative virtual environments can be built to support participants expressions of affect via verbal and nonverbal behaviours in *Virtual reality and collaboration* (Chapter 37). They contextualize their discussions within immersive virtual environment technologies (IVET), where people interact through avatars that act as proxies for their own identities. The chapter reviews the history and common architectures for these IVETs and concludes with a discussion on their ethical implications.

Chapter 38, *Unobtrusive deception detection*, by Aaron Elkins, Stefanos Zafeiriou, Judee Burgoon, and Maja Pantic focuses on an aspect of human-human communication that is of great importance in an era which struggles to strike a balance between security and liberty. This chapter explores algorithms and technology that can be used to detect and classify deception using remote measures of behaviors and physiology. They provide a comprehensive treatment of the topic encompassing its psychological foundations, physiological correlates, automated techniques, and potential applications.

As Cowie notes in his chapter on ethics, “its (ACs) most obvious function is to make technology better able to furnish people with positive experiences, and/or less likely to impose negative ones.” In line with this, the last three chapters explore how AC can support health and wellbeing. It is widely known that socio-emotional intelligence is at the core of autism spectrum disorder (ASD). In Chapter 39, *Affective Computing, emotional development, and autism*, Daniel Messinger, Leticia Lobo Duvivier, Zachary Warren, Mohammad Mahoor, Jason Baker, Anne Warlaumont, and Paul Ruvolo, discuss how AC can serve as the basis for new type of tools for helping children with ASD. The tools can be used to study the dynamics of emotional expression in children developing normally, those with ASD, and their high-risk siblings.

One approach to healthcare is to use avatars that simulate face-to-face doctor-patient interventions. In *Relational agents in health applications: Leveraging Affective Computing to promote healing and wellness* (Chapter 40), Timothy Bickmore surveys research on how affect-aware relational agents can build patient-agent rapport, trust, and the therapeutic alliance that is so important in healthcare practices.

In principle, any technology that can help people change mindsets and behavior can be used to improve psychological wellbeing. In the last chapter of the Handbook (Chapter 41), entitled *Cyberpsychology and Affective Computing*, Giuseppe Riva, Rafael A. Calvo, and Christine Lisetti propose using AC technologies in the wider context of personal development, an area being called positive technology/computing.

### **The Glossary**

One of the biggest challenges in interdisciplinary collaborations, such as those required in AC, is the development of a language that researchers share. The disparate terminology used in AC can be overwhelming to researchers new to the field. There is additional confusion when researchers redefine terms for which there are more or less agreed upon operational definitions. It is our hope that the *Handbook of Affective Computing* will help develop this common understanding. To facilitate the process, we have included a glossary developed collaboratively by the contributors of each chapter. We asked all contributors to identify key terms in their contributions, and define them in a short paragraph. When more than one definition was provided, we left all versions, acknowledging that researchers from different backgrounds will have different terminologies. Hence, rather than forcing the common definition, the glossary might be a useful tool to minimize what is often “lost in translation”.

### **Concluding Remarks**

It is prudent to end our brief tour of the *Handbook of Affective Computing* by briefly touching on its origin. The Handbook emerged out of brief conversations among the editors at the 2011 *Affective Computing and Intelligent Interaction (ACII 2011)* conference in Memphis, Tennessee. We subsequently sent a proposal to Oxford University Press, where it was subsequently approved and the rest is history. By touching on the history and theory of Affective Computing, its two major thrusts of affect detection and generation, methodological considerations, and existing and emerging applications, we hope that the first *Handbook of Affective Computing* will serve as a useful reference to researchers, students, and practitioners everywhere. Happy reading!!

## **Acknowledgements**

The Handbook would not have been possible without the enthusiasm of the authors who have volunteered their time to share their best ideas for this volume. We are very much indebted to them for their excellent work. We could not have achieved compiling and preparing the Handbook without the support of Oxford University Press, and here particularly Joan Bossert and Anne Dellinger, as well as Aishwarya Reddy at Newgen Knowledge Works. We are grateful to Jennifer Neale at University of Notre Dame and Agnieszka Bachfischer at the Sciences and Technologies of Learning Research network at the University of Sydney for administrative and editing support.

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