Chapter 1
Introduction to Cyberemotions

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1.1 Introduction

Even a beginner in psychology or sociology agrees that emotions can crucially influence our life and they can do it even without our awareness. "No need to get emotional about it" is a response often heard when trying to calm someone down. But the fact is that we do need to get emotional. Emotions are the backbone of family life; they enable us to react in dangerous situations; they create the group experience of a football crowd, a pop concert or a historical event. Emotions are part of what makes us human. We cannot escape from them since they belong to the core of our human nature. Indeed psychologists define emotions as bodily and social processes, shaped by cultural influences and biological constraints, that are best understood in an evolutionary context (Leventhal and Scherer 1987, see also Kappas, Chap. 3 of this book). A physicist or a mathematician may however be surprised to learn that despite a long history of research on emotional phenomena psychologists can agree neither on the number of basic emotions nor on the number of variables that are needed to describe emotional states. It is after all largely accepted that emotions should refer not only to the feeling component, but also to an expressive behaviour in the face or the voice as well as to bodily changes, such as differences in sweating, the frequency with which the heart beats or shifts in the activation of certain brain parts. In brief, emotions exist both in our mind and body (if one has the right to separate these two).

With information technology occupying such a central part in all our lives, it's important to ask whether there are emotions in cyberspace too? Since cyberspace is just another human space, it's bound to have an emotional context. However, it possesses special features that make social interactions between people different

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J.A. Hołyst (ed.), *Cyberemotions*, Understanding Complex Systems,
DOI 10.1007/978-3-319-43639-5_1

from those taking place in the offline world. One difference is the often much shorter lifetime of e-communities compared to their offline counterparts. Since participants of internet forums or discussion groups are also less bounded by local social norms, they may interact more quickly and express their feelings more often. The internet, for example, is well-known as a site for the expression of strong emotions, for example in "flaming". It also hosts many environments in which multiple participants engage with others.

What's to be gained by studying such phenomena? Well, firstly understanding how emotions and intuition interact with information technology could help us to build better ICT systems. Humans might also benefit from ICT systems that were able to react emotionally and, ultimately, that were sensitive to emotions. More fundamentally, modelling emotions in artificial systems might also add to our understanding of humans at a psychological level. Emotions are complex processes. Behaviour, expression, physiological changes in the brain and in the body at large, motivational processes, and subjective experience are just some of the factors involved. These components are only loosely related (what researchers call 'exhibiting low coherence'). They are constrained by our biology but also constantly shaped and modulated by social and cultural contexts. And there is constant mutual interaction with processes such as attention, perception, and memory. All of this serves to make the study of emotions a challenging field of science.

Being partly social processes emotions influence our group relations and vice versa—they are dependent on social interactions. Emotional experiences are frequently shared with members of social networks which strengthens social ties. This echoes the dynamics of epidemic propagation since reproduction of the sharing process enables propagation of emotions and results in emotion multiplication as well as the emergence of collective emotional patterns. In this way emotions very generally elicit a process of social sharing of emotional experience (Rimé, Chap. 4). When an external emotional impact simultaneously influences members of a social group it provokes a number of discussions where emotions are reinforced and people sharing the same emotions get a feeling of belonging to the same community.

In the present digitalised world the spreading of emotions becomes easier since new kinds of social links are possible (Carr et al. 2012; O'Reilly 2005) and they can be much effortlessly created as compared to face to face contacts (Walther 2011, Krämer et al., Chap. 2). It follows that social sharing can be reduced to simple post forwarding or re-tweeting which may lead to emergence of collective emotions in larger groups. Such states can be also elicited by an external event that has attracted attention a large group of internet users, e.g., the death of a media star or a special sporting event (Chołoniewski et al. 2015).

Members of e-communities frequently make use of their apparent anonymity to express their opinions and emotions in a more open way (Suler 2004). Unfortunately, this advantage of on-line communication possesses also a darker side: receivers of negative emotional messages can suffer from a serious emotional discomfort when the posts target their fragile points—an action commonly known as cyber-bullying (Berson et al. 2004). The effect is enhanced during synchronized

attacks of so-called haters and can result in depression or even suicide for victims (Sourander et al. 2010).

Studies of emotional processes in human brain and body are frequently performed in special labs using psychophysiological methods such as facial electromyography and electrodermal activity (Küster and Kappas, Chap. 5). This kind of methodology is impossible to apply when one is interested in the emotional behaviour of social groups with millions members. In the case of e-communities such large scale studies are feasible due to *sentiment analysis that deals with the computational treatment of expressions of private states in written text* (Quirk et al. 1985, Paltoglou and Thelwall, Chap. 6). Two main sentiment analysis approaches are *machine learning algorithms* and *lexicon-based solutions*.

Machine learning methods of sentiment analysis exploit pre-annotated data (e.g., a set of sentences or longer text segments) that serve as examples of specific emotional contents. During the initial training phase special machine learning algorithms such as Naive Bayes, Maximum Entropy or Support Vector Machines try to discover hidden rules describing the presence of a given sentiment in the text. Once such rules have been found they can be used for automatic detection of sentiments in a text that has not been annotated by humans. Because of the necessary training phase these kind of algorithms are called *supervised methods*. Their main weakness is a dependence on a pre-annotated text set that can be non-representative for other domains, e.g., algorithms trained on political discussions can have a limited efficiency for detecting sentiments in product reviews (Paltoglou and Thelwall, Chap. 6)

Lexicon-based methods do not need a training phase with pre-annotated texts. Instead they use *lexicons*, i.e., emotional dictionaries that include information on the emotional contents of some words. The methods also apply lexical rules that take into account how emotions are expressed in a given language. The final estimation of sentiments is dependent not only of detected emotional words but also on the presence (and position) of special *prose signals* (Paltoglou and Thelwall, Chap. 6) such as negation, capitalization, exclamation marks, emoticons, intensifiers and diminishers.

Although lexicon-based sentiment detection algorithms can operate without a training phase and are called unsupervised methods one can enhance their efficiency by adding additional training. In such a case the algorithm optimizes its lexicon term weights for a specific set of human-coded texts. The *SentiStrength* algorithm uses idiom and emoticon lists as well several other rules such as increasing sentiment strength when CAPITAL letters are found. SentiStrength can score each can text with dual positive and negative scales simultaneously which corresponds to psychological observations of humans. In fact one can experience positive and negative emotions at the same time (Norman et al. 2011). Properties of the SentiStrength algorithm are discussed in detail in this book (Thelwall, Chap. 7).

The availability of large datasets containing sentiment scores has encouraged physicists to study emotional patterns using tools from statistical physics. One of the fundamental issues is the detection of emotional sharing in e-communities. It is well known that physical interactions between atoms or molecules can lead to the

emergence of collective states with an appropriate order parameter (Stanley 1987). It is however a priori not clear if the concept of order parameter can be introduced for social systems with emotional interactions. One of the special features of on-line discussions is the fact that different participants rarely present their emotions (or opinions) at the same time. It follows that a quantitative description of emotion sharing should take into account *time series* of consecutive values corresponding to emotional valencies, arousal and other emotional components rather than from a single number describing the mean value of an emotion observable.

The *order* of appearance of different emotional comments contains significant information about the social sharing of emotions and the strength of emotional interactions. When a few negative comments increases the chance of the next comment being negative then the time series is persistent and one can anticipate the presence of emotional interactions related to sharing negative emotions. The level of this persistence can be measured in many ways, e.g., by appropriate conditional probabilities (Hołyst et al., Chap. 8) Hurst exponents (García et al., Chap. 10) or spectra of emotional avalanches observed in social networks (Tadić et al., Chap. 11). Data-driven agent-based models of virtual emotional human can describe these features provided that an appropriate way of *emotional communication* (García et al., Chap. 10) and/or parameters of hidden topology of underlying social community (Tadić et al., Chap. 11) are assumed. It is interesting that the level of emotional interaction does not only influence a strength of individual social links but emotions can be also a kind of fuel for the existence of the on-line group and in many cases the decay of this fuel leads to group death (Sienkiewicz et al., Chap. 9).

Studies of communication in specific on-line groups take into account the time-dependent topology of the emerging social network and resulting patterns of bi–directional emotional relations. Such observations give evidence (Trier and Hillmann, Chap. 12) of *an emotional balance* for individual agents, i.e., a given agent expresses both negative and positive emotions. There is however a strong positive or negative emotional polarization of specific *links* between different agents. The polarization possesses usually a reciprocal (symmetrical) character and when triangles of interacting agents are studied then a Heider balance (Heider 1946) known from groups communicating in a direct way is observed (friend of my friend is my friend, enemy of friend is my enemy etc.).

It has been known since the times of Darwin (1872) that human beings and animals (unconsciously) communicate their current state of mind through facial expressions and body gestures. However, currently a majority of on-line communities rely on text messages as a medium of communication and it is quite possible that it will remain so even if supported by images and video. The popularity of this communication form has its roots in degree effectiveness of the written form of language for conveying meaning with a small number of signs. Nonetheless, as raised by Morris (1978) text exchanges filter out the large range of non-verbal communication channels and it turn can lead to ambiguity in case the text content lacks redundancy about the expressed meaning. Therefore it is often just essential to use of a complementary *visual* communication channel in the form of an *animated 3D avatar* to convey the potential emotions carried by the text messages. For the

above stated reasons scientists struggle to provide an automated mapping of an emotion model to real-time facial expressions and body movements (Boulic et al., Chap. 13).

Another impact of research on emotions in on-line communities is the development of Interactive artificial systems (IAS) that would take into account sentiments during human-computer communication (Skowron and Rank 2014). In principle, interactive affective systems can communicate with users directly, provide new content to a group of users, and provide reports on group activities identifying interaction patterns. IAS aim to model the affective dimensions of multi-party interactions, to simulate potential future changes in group dynamics, and, in part based on that information, to suitably respond to utterances both on the content and the affect level (Skowron et al., Chap. 14)

1.2 Book Description

The book is divided into four distinct parts corresponding to different layers: (I) Foundations, (II) Sentiment analysis (III) Modeling and (IV) Applications.

The first part is a vivid discourse between psychologists, social psychologists and psychophysiologists regarding the role and function of (cyber)emotions. As most of us are frequent users of such applications as YouTube or Facebook it is essential to find out what is the status of the current scientific knowledge about social and emotional aspects of those applications. This subject is tackled by Nicole Krämer et al. in the first chapter. Yet, a probably even more fundamental question is next asked by Arvid Kappas: *how we define emotions?* Moreover, the author comes also with a working definition of "cyberemotions"—a common denominator of all the works that constitute this very book. As already mentioned, another important aspect of emotions is them being the trigger of social sharing process. The general framework of this phenomenon is widely discussed by Bernard Rimé in Chap. 4 along with some perspectives on cyberemotions. The final chapter of "Foundations" touches the problem of measurement of emotions in individuals—Dennis Küster and Arvid Kappas give the psychophysiologist's point of view, focusing on multi-modal assessment of emotions in the lab. Here we can find out about paradigms particularly tailored for research of cyberemotions which are illustrated with concrete examples of recorded data.

Although the next part, "Sentiment analysis" may look like quite disjoint from its predecessor, it is a key input for the following "Modelling" and "Applications" sections. From Georgios Paltoglou and Mike Thelwall, authors of Chap. 6, we learn about the methods that concern computational detection and extraction of opinions, beliefs and emotions in written text. Those solutions come from of lexicon-based algorithms (i.e., previously created dictionary) or machine learning approaches that automatically or semi-automatically learn to detect the affective content of text. In Chap. 7 Mike Thelwall recapitulates those considerations by presenting the successful fruit of their lab—the SentiStrength program—along with the ways it can

be refined different topics, contexts or languages. The chapter also briefly describes some studies that have applied SentiStrength to analyse trends in Twitter and You Tube comments.

The authors of four chapters that form the "Modelling" part had a particularly difficult task: being physicists, specializing in complex systems, to analyse the on-line sentiment-annotated data taking into account the theories of emotions and specific phenomena connected to them. The group from Warsaw University of Technology resolved this issue by first showing signs of collective emotions and their homophily in clusters of messages (Chap. 8) and then addressing the problem of non-stationarity in on-line discussions, underlying the necessity of an emotional imbalance for the thread to last (Chap. 9). On the other hand, David García et al. present in Chap. 10 a carefully designed, elegant and complete agent-based model that combines two main dimensions of emotions—valence and arousal. An application of this modelling framework to different online communities is shown as well as the way it reproduces the properties of collective emotional states in different media (Amazon, IRC channels). The framework is then adapted by Bosiljka Tadić et al. (Chap. 11) to successfully reproduce the stylized facts observed in the empirical data of online social networks, indicating group behaviour arising from individual emotional actions of agents.

The fascinating "Application" part gives the reader a glimpse of the possibilities that come when we introduce emotional components to computer applications. Chapter 12 by Matthias Trier and Robert Hillmann is a good example of the intersection between social and computer sciences by setting the scope of interest on network motif analysis. In particular, the authors show that users develop polarized sentiments towards individual peers but keep sentiment in balance on their ego-network level. Graphically most advanced chapter in this book—Chap. 13 by Ronan Boulic et al.—brings forward the issue of non-verbal facial and body communication, focusing on the instantaneous display of a detected emotion with a human avatar, reconsidering the expressive power of asymmetric facial expression for better conveying a whole range of complex and ambivalent emotions. In the final Chap. 14 Marcin Skowron et al. follow the line of futuristic examples of emotion application by presenting how interactive affective systems can be used to study the role of emotion in online communication at the micro-scale, i.e. between individual users or between users and artificial communication partners.

1.3 CYBEREMOTIONS Project

The book presents in a large part research results of CYBEREMOTIONS project (Collective Emotions in Cyberspace, 2009–2013) that was an EU Large Scale Integrating Project within the 7th Framework Programme in FET ICT domain Theme 3: Science of complex systems for socially intelligent ICT. The project associated nearly 40 scientists from Austria (Österreichische Studiengesellschaft für Kybernetik), Germany (Jacobs University and Technische Universität Berlin), Great

Britain (University of Wolverhampton), Poland (Warsaw University of Technology and Gemius SA), Slovenia (Jožef Stefan Institute), and Switzerland (ETH Zürich and École Polytechnique Fédérale de Lausanne).

The main objectives of CYBEREMOTIONS were to understand the role of collective emotions in creating, forming and breaking up ICT mediated communities and to prepare the background for next generation of emotionally-intelligent ICT services. Project Partners collected data on emotions in e-communities and psycho-physiological data on emotions evoked by on-line discussions, developed data-driven models of cyberemotions, and created emotion-related software.

CYBEREMOTIONS met successes in all domains of its activity. Data collected in the Project from blogs, forums, portals, IRC channels, `Twitter` and `MySpace` are ranked among "the 70 Online Databases that Define Our Planet" (TechnologyReview 2010). Also several experimental setups provided a microscopic view on affective processes associated with reading and writing contents on the Internet. Our `SentiStrength` (SentiStrength 2016) program is considered as a one of the most advanced tools in sentiment detection. Theoretical models based on active agents approach, complex networks and stochastic processes are able to describe several stylized facts for emotional dynamics in social groups communicating by Internet.

Outputs of the Project were used for creating new affective dialog systems as interactive tools as well as semi-automated simulation of facial expression through a user's 3D avatar that can facilitate the process of the online affective communication. The Project delivered network visualization tools for effective demonstration of emotional contagion processes in social networks.

Acknowledgements I would like to express my gratitude to all the Partners of CYBEREMOTIONS Consortium for a very fruitful collaboration during the whole Project period and for their contributions to this book. I am also indebted to external experts that prepared additional materials presented in Chaps. 2 and 4. Last but not least I am very thankful to Dr. Julian Sienkiewicz who did a splendid job by compiling and synchronizing individual files in the single volume. This work was supported by a European Union grant by the 7th Framework Programme, Theme 3: Science of complex systems for socially intelligent ICT. It is part of the CyberEmotions project (contract 231323). The work was also supported by Polish Ministry of Science Grant 1029/7.PR 631 UE/2009/7. I acknowledge in addition a Grant from The Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS) and support from European Union COST TD1210 KNOWeSCAPE action.

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