Chapter 5.9
Automatic Detection of Emotion in Music:
Interaction with Emotionally Sensitive Machines

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ABSTRACT

Creating emotionally sensitive machines will significantly enhance the interaction between humans and machines. In this chapter we focus on enabling this ability for music. Music is extremely powerful to induce emotions. If machines can somehow apprehend emotions in music, it gives them a relevant competence to communicate with humans. In this chapter we review the theories of music and emotions. We detail different representations of musical emotions from the literature, together with related musical features. Then, we focus on techniques to detect the emotion in music from audio content. As a proof of concept, we detail a machine learning method to build such a system. We also review the current state of the art results, provide evaluations and give some insights into the possible applications and future trends of these techniques.

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INTRODUCTION

Why do people enjoy music? One of the main factors is that music easily induces emotions and affects the listener. Can machines enjoy music as people do? Or, surely easier and less philosophically debatable, can we develop systems that are capable of detecting emotions in music and use this ability to improve human-machine interaction?

Stating that music and emotions have a close relationship is no revelation. One significant motivation of composers is to express their senti-

ments, performers to induce feelings, and listeners to feel emotions. There are also some findings that show a direct link between audio processing and emotion in the brain, which is not so clear for other sensory modalities. Moreover music has a noticeable social role and is ubiquitous in everyday life. To communicate with humans using musical emotions, machines should be able to detect and predict them. Enabling this ability will enhance the communication between the machine and the environment. First they can sense the acoustic scene with a microphone. The surrounding music can be understood in terms of emotions and the machine can react accordingly. The face of a robot can give an explicit feedback of the emotions it detects. Moreover robots with musical abilities can select, play and even compose music conveying targeted emotions. The technology we detail in the remainder of this chapter enables machines to detect emotions from raw audio material, which is directly extracted from the digital signal. In this chapter we expose the main findings about music and emotions, together with techniques in artificial intelligence and more explicitly in machine learning to create emotionally sensitive machines.

This chapter is structured in four parts. In the first section we comment on the relationship between emotion and music and review theories from different expertise. In section 2 we define the machine learning techniques that can be used to create emotion aware machines; we detail also the methodology and give evaluation results from state of the art research in this area. Then, in section 3, we develop some ideas around emotion-based music assistants. Finally, in the last part, we present some general observations and give future perspectives.

SECTION 1. MUSIC AND EMOTIONS: EMOTION IN MUSIC AND EMOTIONS FROM MUSIC

To study the relationship between music and emotion, we have to consider the literature from many fields. Indeed, relevant scientific publications about this topic can be found in psychology, sociology, neuroscience, cognitive science, biology, musicology, machine learning and philosophy. We focus here on works aiming to understand the emotional process in music, and to represent and model the emotional space. We also detail the main results regarding the pertinent musical features and how they can be used to describe and convey emotions.

Why Does Music Convey Emotion?

Emotion and expressive properties of musical elements have been studied since the time of ancient Greece (Juslin and Laukka, 2004). The fact that music induces emotions is evident for everyone. However we do not intuitively apprehend why. Emotions are mostly said to be complex and to involve a complicated combination of cognition, positive or negative feeling changes, appraisal, motivation, autonomic arousal, and bodily action tendency or change in action readiness.

One of the first things to clarify is the definition of an emotion and the difference between emotions and moods. The concept of emotion is not simple to define: “Everyone knows what an emotion is, until asked to give a definition” (Fehr and Russell, 1984, p. 464). It could be defined as an intense mental state arousing the nervous system and invoking physiological responses. According to Damasio (1994), emotions are a series of body state changes that are connected to mental images that have activated a given brain subsystem (e.g., the music processing subsystem). So emotions involve physiological reactions but also they are object-oriented and provoke a categorization of their object: “if the emotion is one of fear its object must be viewed as harmful” (Davies, 2001, p. 26). Emotions also induce an attitude towards the object. Moods could be considered as lasting emotional states. They are not object oriented and take into account quite general feelings. Moods and emotions can be very similar concepts in