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Analyzing Human Emotions

Introduction

Human beings have always been interested to learn more about the nature of how individuals feel. There have been numerous amounts of research that has been done to try and understand these feeling that a person gets in certain situations. Having a specific emotion affects the way one views society and life in general. Emotions range from positive to negative reactions that are unique to every individual. Recently with the advances in technology experts want to take these ideas about human emotion and try to develop models to further help in figuring out a person's emotional state at a certain time in a given situation. The main goal of this paper is to talk briefly about the history of human emotions and what is affective computing. In addition, take a look at models to compute human emotions and possible applications in the real world.

What is human emotion?

The term emotion can be traced to the year 1579 that derives from the French word emouvoir, which means to stir up. Human emotion can date back to 1590 by a philosopher known as Rene Descartes. He is one of the many known scholars to provide an idea about emotions and their impact. Descartes gave the notion that there are a few basic emotions that influence the life of a person. Charles Darwin also theorized that emotions are influenced by

evolution and as a result influences your behavior in nature. The idea of emotions has been shaped in various different fields such as biology, philosophy, and psychology. Although many fields influence emotions, it is generally collected in a field known as a psychological tradition. In addition, although Descartes proposed that there are basic human emotions that influence our lives isn't necessarily true. It makes it difficult to set a standard for basic human emotions because different feelings can have multiple meanings. For example, raising your eyebrows can mean you were in a state of surprise or you were in a state of shock. Another reason why there is no basic set of human emotions is that there could be hidden emotions internally that externally you are not able to see. For instance, a person could be giving a big happy smile but in reality they are lying to the other person for what actually could have happened. Human emotions are dynamic which make it very difficult to research every aspect of emotions. We as human being when talking to another person we identify certain clues either in their facial expression or tone of voice to identify what a person's state is at that particular moment. Once we pick up on those clues we are able to determine if a person is happy, sad, confused, or any other emotion. To human beings this is a natural way of determining an individual's state by picking up small hints and processing it simultaneously to come up with a conclusion on the current state of the individual.

Affective Computing

Affective computing is a field where you develop a system that is able to recognize and be able to process human emotions. This field of study ranges from computer science to psychology and cognitive studies. Interestingly, this concentration of study has been around for more than 20 years. The individual who is credited for the creation of this field is Professor Rosalind Picard. Picard was the person who coined the term affective computing when beginning

her research in this field. With her book titled Affective Computing in 1995, she began this branch of computer science study that focuses on a person's emotion. Picard states "emotion plays a major role in perception, memory and attention, rational decision making and in human computer interaction" (Keary, Walsh pg.24). Emotions play a big role in different aspects of our lives from our behavior to decisions we make based on our emotional state. To be able to learn about the complex aspects of emotions in human beings and be able to apply it would greatly impact the improvement of technology and improve lives of humans overall.

Facial Recognition Techniques

Some techniques used to analyze human emotion derive from a system known as Facial Action Coding System or FAC. With this system they are able to use Action Units or AU to assign a value to a facial expression. FDP (Facial Definition Parameter set) as well as FAP (Facial Animation Parameter set) was developed using the MPEG-4 standard to observe human emotions. MPEG-4 standard supports files such as audio and video storage files, which is useful if you want to identify human emotions. FDP allows you to define particular emotions based on particular features of the face or any wrinkles produced when displaying a specific emotion. Then the FAP detects those wrinkles and features and is able to interpret those expressions into basic facial movements. For example, if you display a happy emotion the FAP will recognize the movement of your lips moving to identify that the person is happy. Any small movement of the face expressed it will be detected. Once the system recognizes a particular facial movement and expression, then it will be translated into numerical values known as the FAPU or Facial Animation Parameter Units. Since it was derived from FAC, it will assign a numerical value to a specific part of the face. The FAP can be divided into two separate categories. There is a low-level FAP that consist of 66 different values for human emotions that can be measured. These

values consist of small movements in the face that is used to form the most common facial expressions. Next we have the high-level FAP, which only consists of 2 parameters. These parameters are used for more complex facial expressions that can't be identified right away. Some expressions in the human face can't be expressed such as the feeling of death or just resting. Both expressions would be similar in the values measured but it would make it difficult to categorize whether it is a happy or sad emotion.

Another technique used for facial recognition is known as the Optical Flow-Based approach. Optical flow is used to detect the movement of a particular object or surface. It mainly uses arrows to measure the direction and speed of a particular object. For the use of facial detection, it is focused on only a few areas of the face that include the lips and your eyes for any type of movement. It is used to detect any slight variation in facial expression as a result creates a local estimate to determine the motion of the object. Using those estimates from the optical flow, the technique was able to recognize some of the most common human emotions. Ohya et al., on the other hand, used this same technique but applied another method called the Hidden Markov Model (HMM). This model is used to determine probabilities of sequences over a period of time. In the figure below, this is an example of how the Hidden Markov Model works.

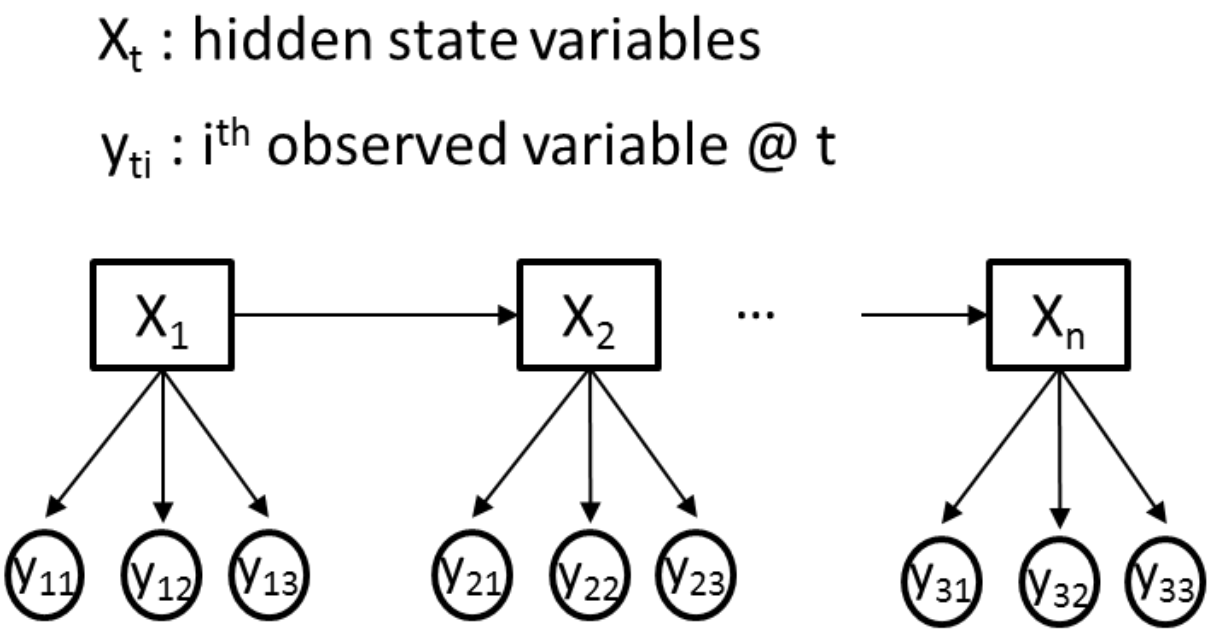

Figure 1 Hidden Markov Model

The boxes labeled X represent the state that an object is currently in. Next, you have the Y which represent all the possible probabilities from the various states. Ohya et al. used this to determine all the possible probabilities from a given set of human emotions. Once the outputs have been obtained, the values were then applied to a vector space. In the vector space, you would plot the specific value to a 2 Dimensional Graph. Thus it would match the value from the probability to the value for a specific human emotion. As a result, the effectiveness of recognizing a human emotion had a success rate of more than 80%.

Speech Recognition

Another technique that is used to recognize human emotions is by analyzing human voice. Similar to detecting human facial expressions, a human is able to recognize certain vocal patterns when communication is taking place. For instance, when you hear screaming you can automatically break down the tone and based on your knowledge you can categorize whether

people are scared or they are angry towards someone else. To develop such device to recognize speech and translate it to emotions comes down to teaching the machine how to recognize patterns. One method used to be able to detect emotion through speech is called SVM-BDT (Support Vector Machine utilizing Binary Decision Tree). A SVM is a way to be able to classify various types of data. Data can be plotted on a plane and you are able to draw a line in any type of orientation. This type of orientation where you draw a line is known as the Optimal Hyperplane. Once you have several possibilities, you have to determine which hyperplane gives you the best way to classify sets of data from one another. The line that gives you the best separation also known as a margin away from the data points will give you the best classifier of the data. Once you have used the SVM to extract particular features you then develop the Binary Decision Tree. For example, let's assume you have a root of the tree with 7 different emotions. Using the SVM classifications gathered before, you extract one feature from the graph and match it with a particular emotion. From the 7 emotions, it will break up into different groups depending on the emotions you are using. You continue to repeat the process until you are left at the bottom of the tree with individual emotions. In the SVM graph, there will be 7 different colored regions classifying each of the 7 different emotions in a particular category.

Possible Real World Applications

With this type of technology it makes various systems have a more natural interaction with a human in order to better adapt with the system. Another way that this type of study can be used is to help a person during a tutoring session. The system will be able to analyze either the person's facial expressions or with the sound of their voice to determine if the individual is struggling or frustrated with a certain problem. The tutor will have a better understanding of the state of the person is and what type of approach he or she should use to help the student out. In

addition, it could also be used to analyze an unknown individual from other parts of the country. Since different emotions have other meanings in various cultures it could give some insight on where someone comes. Certain situations trigger a particular emotion and give some sort of indication of where someone possibly came from. Furthermore, this would be effective in the gaming industry. Based on the human emotion of the player it could assess whether the person is engaged during gameplay or simply just bored. Based on the information, gaming developers can use this information to improve gameplay experience as well as their interaction with characters in the game too. Not only does it help in the gaming industry but it could possibly improve the medical industry as well. By being able to analyze the emotional state of a patient can a doctor assess the right medication or determine what disease is related to particular kinds of emotional responses. Finally, it could be used to analyze people when watching TV to gather data about what type of commercials people liked and how other commercials didn't capture their attention so much.

Conclusion

Recognizing human emotions is quite fascinating. The ability for a human to be able to recognize clues to determine another person's emotional state naturally demonstrates a really amazing aspect of the human being. Many famous historical figures from biology, psychology, and philosophy have also taken a look at this idea of emotions and the type of impact it has. Due to the interest in human emotion, the discipline known as affective computing came to be to learn more about human emotion and to develop systems to replicate human characteristics. Within this field, there have been many models used to try to build a system to be able to recognize and determine human emotions as effectively as how a human would naturally with another individual. Although the applications to detecting human emotion could be beneficial,

there is still further studies to be made. Furthermore, the knowledge and technology in human emotion is still in the early stages of development. With future work this theory can be applied and make a great impact into various fields of study.

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