
Sensing Stress Network for Social Coping

Mashfiqui Rabbi

Information Science, Cornell University
301 College Avenue
Ithaca, NY 14850 USA
ms2749@cornell.edu

Syed Ishtiaque Ahmed

Information Science, Cornell University
301 College Avenue
Ithaca, NY 14850 USA
sa738@cornell.edu

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Abstract

The behavioral and social factors associated with stress have been extensively studied in literature for many years. A body of recent works demonstrated how stress is reflected in individual's everyday behavior, and can be measured by sensors. Studies show that many of these behaviors are socially constructed. However, little has been done to find the stressors in one's social network and help one cope accordingly. We propose here a system to find the stress network around an individual that contributes to her stress status. Furthermore, we also present a strategy for coping by exploiting this stress network. We argue that our proposed design can benefit individuals by making them more stress-resilient over time by exploiting their social bonds.

Author Keywords

Stress; Sensor; Social Coping; Network Discovery

ACM Classification Keywords

H.1.2. User/Machine Systems

Introduction

Stress is a universal phenomenon of modern life. In a recent study by American Psychological Association, three quarter of Americans are reported to have stress-related symptoms [1]. While repeated or chronic stress can cause adverse physiological problems likes obesity

and hypertension, inability to cope with stress can cause mental disorder like anxiety and depression [4].

An essential component of getting accurate information about stress is to measure stress in real life settings. Current standard and validated ways to measure real life stress mostly involve use of surveys. However, such survey-based techniques typically measure stress at a monthly scale [3]. Thus these measures suffer from recall biases, and fail to capture finer level details of in-situ stress appraisal and most importantly sources of stress. Also, during stressful conditions people's focus increases for tasks at hand [7]. Consequently, it becomes difficult to be mindful and self-reflecting about sources of stress and coping strategies at a later time. In fact, according to relapse prevention theory, almost 30% cases people fail to continue a certain behavior (including mindful stress prevention treatments) because of stressful situations [11].

An alternate low-effort way of measuring stress can be from physiological responses. Human bodies are hard-wired [4] to respond during stressful situations in certain specific ways. Among other responses, heart rate increase and sweating are common changes during stressful episodes. Commodity devices like the *Basis B1* band [2] can detect such heart rate fluctuations and changes in skin resistance due to sweating.

Modern day smartphones can provide a better alternative for detecting both physiological and psychological stress. The *StressSense* project by *Hong et al.* [6] showed the feasibility of continuously measuring stress by analyzing audio from a commodity smartphone in a privacy sensitive way. Also, *EmotionSense* [10] used audio to detect different kinds of emotions from mobile microphone data. *Wyatt et al.* [13] described the use of audio for detecting conversation in a privacy sensitive way. The same work showed methods to detect who is speaking when and how they are speaking (pitch, speaking rate and loudness). Such information reflects dominance (an

equivalent measure of power) [5], emotion [10], stress [6] and engagement in conversation. With combination of these techniques we can quantify: (1) who the user is speaking with, (2) relative power positions in conversations, and (3) emotion and stressful conditions in everyday conversations.

However, studies also show that stress is often created through social mechanisms, and it also propagates through social relationships. *Lazarus* demonstrated how confrontation with a stressor creates stress in individuals through primary and secondary appraisals [9]. According to *Kessler et al.*, stress is often a consequence of a social relationship that exerts power. Their study showed that social support could play an important role in coping [8].

Our work is built upon these two bodies of work, one of which is measuring stress from physiological symbols using sensors, and the other is relating stress to social phenomena. In our proposed design, we extend the existing sensing system research to find out the stress network to understand individuals' relationships with their social peers in terms of stress. Later, we exploit this information to design a recommendation system that helps individuals find appropriate persons in their social networks to cope with stress.

In the subsequent sections, we describe how we extend the sensing technology to discover the stress network around an individual. Next we present our strategy for social coping by exploiting that stress network. We conclude the paper with a discussion of our system and future works.

Network Sensing

We construct a directed weighted network among the individuals in a community based on their stress status. We assume a society with n number of people P_1, P_2, \dots, P_n . At a specific time t , the Stress status of a person in that society is denoted as $SP(t)$. Suppose, person i talks with another person, j within the time range t_1 to

t_2 , ($t_2 > t_1$). So, we measure the difference in their stress status by $dS_{P(i)}(t_1, t_2) = S_{P(i)}(t_1) - S_{P(i)}(t_2)$. If the value of $dS_{P(i)}(t_1, t_2)$ is positive, we realize that the conversation helped person i to cope his stress by $dS_{P(i)}(t_1, t_2)$. Other wise we conclude that conversing with P_j causes more stress upon P_i . We assume that the change in one's stress level during a conversation is solely caused by the conversation itself, and we ignore the effect of any other external factors for our proposed design. The average change in P_i 's stress status while talking to P_j , is simple denoted by $DS(i, j)$ and the change in P_j ' stress status during this time is denoted by $DS(j, i)$. Next we construct a network where the nodes represent the individuals in a community and the edges represent the stress effect between two individuals. Each of the edges is directed and weighted. The directed edge from node i to node j represents $DS(i, j)$.

In our proposal, we measure the values of DS s using a combination of measures of power, emotion and stress content in real-life social interaction. However, an important research question is how to combine the scores of power, emotion and stress to derive the values of DS . Initially, we will conduct a small data collection session and ask users to rate conversation for stress inducing or stress coping. Then we will construct a regression model to estimate DS from power, emotion and stress. We can also personalize the DS model later based on user input while users are using the application. We subsequently compute a rank by averaging the DS values of all the conversations between two individual. In case of a group conversation, we update the DS values of each of the pair of individuals taking part in the conversation.

Social Coping

In early studies of stress coping, *Robert Sapolsky* [12] emphasized the importance of coping and social support. *Sapolsky* found that primates situated lower in the power hierarchy experience more stress, however while the presence of the other primates can dramatically lower the stress. In humans also such

trends exist with people having close friend and spouses tend to live longer. Another study showed that patients with severe coronary diseases and lacking social support have three times more mortality rate than patients with spouse and close friend [12].

Recently, *Kessler et al.* [8] described the ways stress can be coped by a social peer. A person can get rid of stress (totally or partially) from a person in his social network. They also talked about how a conversation between two people can lessen the burden of stress upon a person. Disclosing one's problem to another, as they indicated, often relieves one from stress. However, social coping depends a lot upon how the "helper" person is behaving. In an ideal case, the helper person should be sympathetic, patient, and supporting. Their work clearly indicated that some stress could be coped through careful conversation. However, their work did not make any suggestion on how to select the appropriate person among all the social peers around an individual who would be the best fit for coping. This is important, because as they indicated a conversation to a wrong person might even accentuate the condition of stress and that could tell upon the person's mental health.

Building on this concept, we here exploit our stress network to find out the most appropriate person in the social network for coping. Our computation tool selects the person in a person's social network who was most effective in helping the individual cope stress. Going back to our proposed network, we find a list of neighbors for each of the individuals and the DS values associated with them. These are basically the incoming edges of a node, which represent the people and amount of stress each of the people in one's stress network exerts upon one. We sort the list and determine who among one's social setting are most helpful in coping. Then the system makes a recommendation of communicating to that person, whenever the user is under stress. The recommendation system includes a list of people

selected from a person's communication network weighted by amount of time the person talked to them, and amount of stress coped after talking to them. The recommendation should also include a suggestion to the user to find the appropriate person themselves to disclose their problems and share their feelings. After looking at their stress network, the users themselves should also be able to make such decisions, and thus resolve the possible errors often committed by automated recommender systems.

Conclusion

Our proposed system is expected to contribute in helping people handle stress in two ways. In the immediate step, we claim that our system would help individuals find appropriate people in their social network to get rid of their stress. This should eventually help them get a better understanding of their surrounding social setting and the social contexts in which they get stressed. The strategy of social coping exploits individual's social relationships and hence, it is more sustainable in a society, and can contribute in making the social bonds stronger.

We also believe that our coping strategy should eventually help people become more stress-resilient over the time. Drawing from Lazarus [9], we realize that the secondary appraisal of stress coming out of a confrontation with a stressor is based on one's lack of confidence about social supports. Lazarus further argued that a person well aware about his social support that can cope his stress is less probable of being stressed in a confrontation. Hence, we believe that our coping strategy should eventually help individual become more stress-resilient over the time. However, careful user studies should be conducted to understand the effect of this system in the long run.

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