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A NOVEL META-MACHINE LEARNING APPROACH TO DIAGNOSE STRESS FROM ENVIRONMENTAL FACTORS USING AUTOMATED KNOWLEDGE GRAPHS

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ABSTRACT

One of the main goals of machine learning is to make a General Artificial Intelligence. Currently, human artificial intelligence researchers work on meticulously manipulating model parameters by hand in order to arrive at highly optimized machine learning models. In the future, a system will be needed such that a software is able to completely arrive at an optimized model to a specific topic all by itself. An increasingly aware human problem is stress, which can oftentimes lead to a variety of health issues. In this study, a novel machine learning platform was created that could learn how to assess the environmental factors relating to stress in a knowledge graph all by itself. Deep learning algorithms, in particular Graph Convolutional Algorithms, were employed to train the software on a small subset of topics in the aim of recreating additional knowledge graphs through automated Internet searches. By using constructed knowledge graphs with input plaintext for specific areas of environmental stressors as a dataset - weather, income, and societal class-, the software was able to accurately train and predict knowledge graphs for environmental stressors outside of its specific training domain for human analysis. These knowledge graphs could then be used in order to diagnose the total environmental stress through an analysis of how much a specific environment would traverse down the constructed knowledge graph.

Keywords: artificial intelligence, graph neural network, deep learning, stress, mental health

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Introduction

Stress is a factor that affects all people at all times of their lives. The idea that some environments may be more stress inducing than other environments is the idea behind this study. For example, a place that is isolated from the rest of the world and has very low temperatures with little green life is most likely going to cause more stress than a place that is not isolated from the rest of the world and has moderate temperatures with plentiful green life and great sunshine. If we can teach machine learning software to be able to diagnose environmental stressors in a reliable manner, then particular environments that cause too much stress can be selected and evaluated to help find and deal with potential factors that cause too much stress.

In this study, we considered five total environmental stressors: weather/geographical location, per capita income, education, societal class (what level of society is that community - poor, rich, middle class), and pollution. All of these examples, given certain conditions, can result in positive stress and negative stress in the long-term.

Weather can have many different impacts on a person's state of mind. Based on the weather and/or the climate, a person could feel happy, sad, mad and more. The geographical location can also affect the stress of a person. The geographical location and weather go hand in hand, as different locations have different climates. We focused on three main topics, pollution, climate change, and storms.

Pollution is a very general topic, and we will be focusing on two subtopics of this, air pollution, and water pollution. Studies have shown that air pollution causes the stress hormones in our body to increase, which leads to more stress. The more air pollution there is, the more stress hormones our body makes, and the more stressed we become. Stress, however, has many complicating factors, such as heart disease, diabetes, and a shorter life span [1]. This is a problem in many heavily polluted cities, such as Beijing. The other type of pollution is water pollution. Water pollution causes stress in a different way. People who do not have clean water to drink will be stressed because they have to find a way to give themselves and/or their family clean drinking water.

The next topic that we will be focusing on is climate change. According to research, the warmer the ambient temperature gets, the more aggressive people get and the higher the suicide rate gets. The more droughts there are, the higher the farmer suicide rate [2].The hotter the climate gets, the less food is given to people, and the more stressed they will get. The other side of climate change is cold weather. This is similar to the drought problem. Crops will die because of the cold which will cause people stress over the loss of food.

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The final topic that we will be discussing is storms. The most basic storm is a thunderstorm. The sound of thunder and the danger associated with lightning bolts makes many people fear thunderstorms. Higher intensity thunderstorms are associated with higher levels of stress, and areas with a lot of storms have on average more people stressed out (the bridge).

However, not all weather causes negative effects. Some kinds of weather like sunny days, breezy days and snow days could cause positive effects, such as joy and happiness.

The amount of money a person makes is a big influence in their stress levels. As mentioned by an article titled "Experienced well-being rises with income, even above $75,000 per year", "studies show that people with larger incomes tend to report greater evaluative wellbeing. They also show that the relationship between income and evaluative well-being is best described as logarithmic. By contrast, just a handful of studies have examined the relationship between income and experienced well-being, which is how good or bad a person feels during the moments of their life" [3]. The socioeconomic status of someone affects their stress levels through being able to afford healthcare and working multiple jobs. The opposite is true with people with a higher economic status, these people do not have to worry about healthcare or multiple jobs, due to them having enough money to buy healthcare and they can support themselves on only one job.

Societal class is shown to impact stress and health, no matter the amount of wealth or style of living. Multiple studies have shown that stress based on social class has triggered both positive and negative stress responses [4]. Positive stress responses can include stress hormones that increase glucose in the bloodstream and increase ability to repair tissues. Negative stress responses can include poorer health and well-being. Those with a higher social class tend to have better access to healthcare and food. Those with a lower social class tend to have limited access to healthcare, and this provides an additional stress factor. Discrimination based on societal class has also been shown to impact a person's well-being. Those who were discriminated against based on social class were shown to have poorer health. Different social classes are shown to be affected by stress differently, both positively and negatively. All social classes, even those who are higher class, are impacted by stress.

The middle class are affected by stress considerably. With 9 out of 10 people identifying as middle class according to a survey by the Pew Research Center, the stressors vary a lot. Multiple things such as schooling, housing, and financial security play a huge economic toll in millions of middle class families. Even though the middle class has been known as financial security, this hasn't been the case for most families.

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The expense of college and further schooling affects middle class families immensely. The average middle-class family does not qualify for financial aid but can not afford to pay for college without scholarships. This could result in young teens getting part-time or in some cases, full-time jobs. However, the meager pay from these jobs is not enough, and the student ends up wasting valuable time that should have gone into studying and instead spends it on a job. This results in these families having to pay off student loans for decades, and their kids needing to work long hours each night making up for missed work due to stress and jobs.

Housing has affected the middle class for a long time. Over 60% of middle class families can not afford to buy a comfortable house, so many end up renting houses. In lots of cases, the cost of renting a house is way too high, and people struggle to make ends meet. Over 2 million Americans are evicted from their homes each year, and that number has been steadily increasing due to the gap between middle and high class widening considerably. In addition, over 30 million people are now on the verge of being evicted from their homes due to the novel coronavirus.

Income plays a huge part in the stressors the middle class face. The higher instability in income affects that as well. The average income for middle class families in the US is $60,000/year. Healthcare itself is over $20,000/family, and combined with other expenses such as EMI and paying rent and bills, just makes it even harder for American families to cope with expenses, resulting in stress. Studies have shown that financial stress makes people up to 20 times more likely to commit suicide. This stress could even lead to problems down the line such as personality disorders. To sum it up, the middle class has just enough wealth to be excluded from financial relief through scholarships, but not rich enough to be free from financial stress.

The upper class has better access to food, nutrition, healthcare, and more. Some perks of the upper class are comfortability with life. They do not face problems with providing for their family, and they live a relaxed and calm life at home, free of stress.

Another perk is access to health care. In the US, healthcare is notoriously pricey, and all it takes is one expensive bill to send a lower class citizen into bankruptcy. "What's more, almost one in three Americans worries about affording health care, according to a February 2020 survey from NBC News. (In June, a man who was hospitalized with Covid-19 for 62 days received a $1.1 million medical bill.)" - Today.com. An average worker would take almost 40 years to save that much. However, the upper class has no such problem. The upper class is defined as the class with the most money and power in society, and with that much money, they have no problem in paying hefty bills, and simply do not have to worry about all that.

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However, they have other stresses. Most upper class citizens are incredibly busy making money, and have business trips abroad very often. Even in their spare time, they are constantly working on future plans in case they venture out of financial security. While this stress is not as severe as the stress that comes from not being able to feed family and making ends meet, it keeps most of the upper class occupied, and without any real work-life balance. This often leaves their kids (if they have any) without parental guidance for most, if not all, of their childhood. With children growing up like this, they often develop depression and extreme loneliness. Overall, while the upper class lives comfortably, they are not devoid of stress.

Poverty causes more stressors such as insecurity in food, housing, income, and more. These stressors can cause an increased risk of mental health problems and substance abuse in the parents, which can lead to child abuse and neglect and cause negative mental health impacts for the child. A number of studies show that cortisol and other stress markers are elevated as a child in poverty. There is some public assistance that helps reduce stress for people in poverty: monthly stipends, help with rent, heating assistance, and food stamps. There are also free medical services. However, these things do not do enough to take away all the stress from people in poverty. Living on a low income can bring multiple stresses such as food and fuel poverty, debt, dispossession, and limited social opportunities. Other stressors are affecting family relationships, harming parents' physical and mental health, and contributing to feelings of stigma, isolation, and exclusion for the whole family.

Software Components:

The software has to utilize several imports using Python to function, all listed below

1. Os
2. Tensorflow
3. Selenium

Technology:

The software starts out by first accepting user input as to what kind of environmental stress factors to check for. In this case, the factors to check for were weather/geographical location, per capita Income, education, or societal class. Upon doing this, the software then goes to a web browser, and searches for information from accredited websites and journals about the stress caused by this factor. The software does this by using a query through the import Selenium. Following this, the software then extracts all textual information from all accredited websites.

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Once this entire body of text is extracted, the software will then extract out only the important pieces of information it can use for the next step through a “filtration process”. Once this textual information is extracted, the software then passes this through another model which is trained to convert the filtered down text into a specific knowledge graph. Once this knowledge graph is then structured, an environment can be analyzed through going through the list of directives and given a statistic as to how stressful it is by how much the environment can go through a list of potential queries without terminating. A descriptive flowchart of this process is shown in Figure 1.

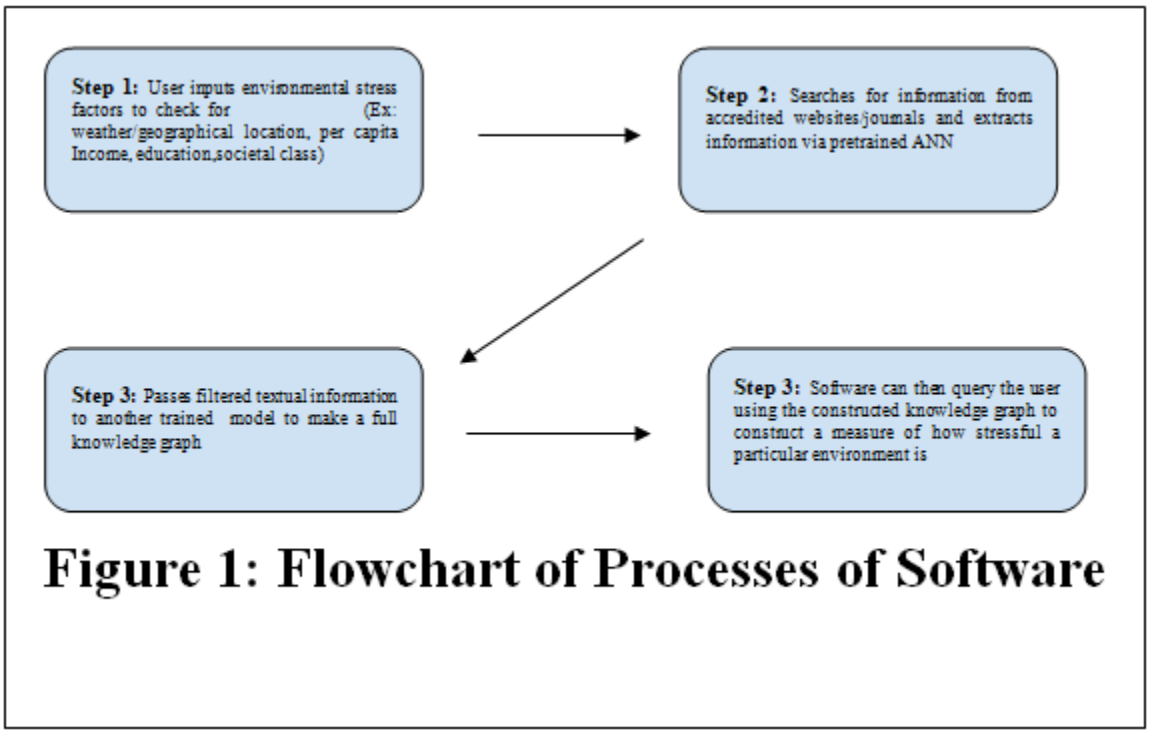

Figure 1: Flowchart of Processes of Software

Dataset:

The research leveraged three independent datasets, which consisted of knowledge graphs for diagnosing stress associated with a particular environment in terms of weather, income, and societal class.

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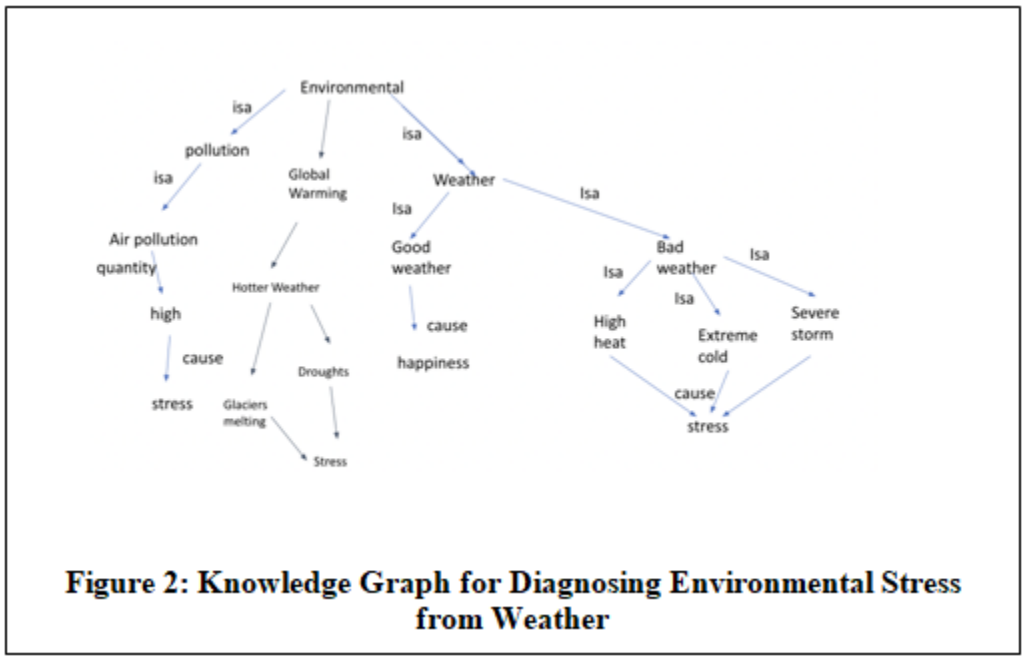

Figure 2: Knowledge Graph for Diagnosing Environmental Stress from Weather

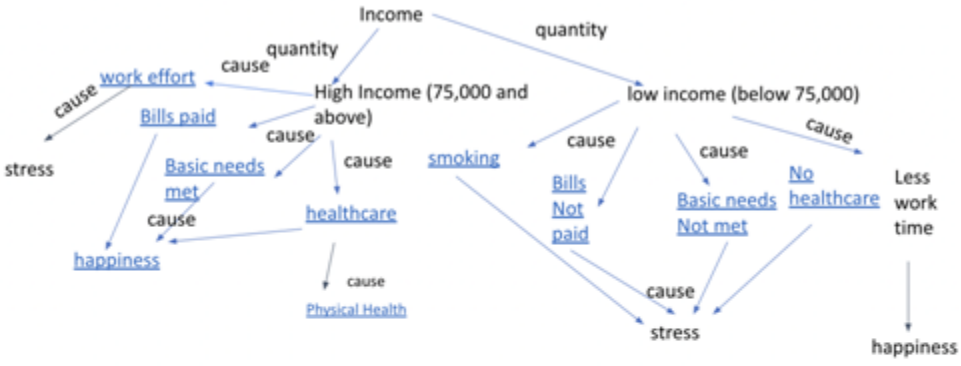

Figure 3: Knowledge Graph for Diagnosing Environmental Stress from Income

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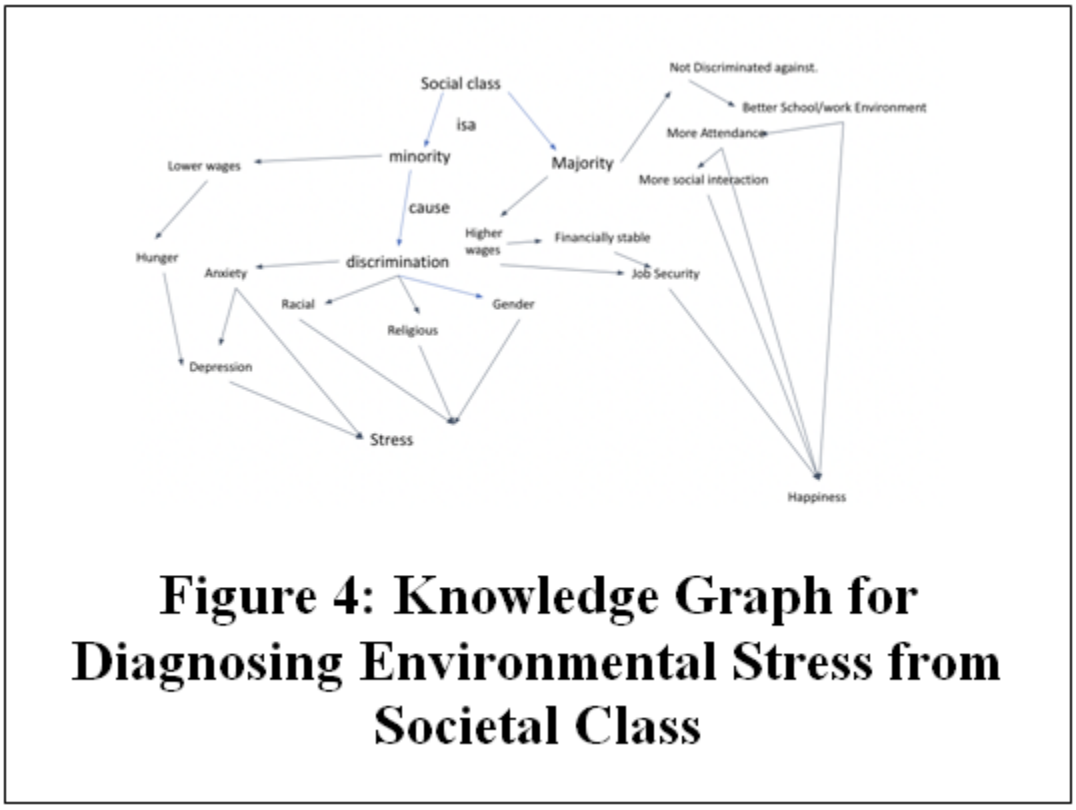

Figure 4: Knowledge Graph for Diagnosing Environmental Stress from Societal Class

The software learned through training on these knowledge graphs and the related textual information used to construct these knowledge graphs.

Algorithm:

An Artificial Neural Network (ANN) was used to identify specific textual information important to add to the knowledge graph from a particular website. Then, a Graph Neural Network (GNN) is used to generate the knowledge graph, and add additional information to the existing graph as more is understood from the ANN. Consistently, Adam was used as an optimizer function and ReLU was used as the activation function, with various parameters changing with each iteration to achieve the best randomized testing results with each trained model.

Model Construction Procedure:

The software initially trained upon all of its data, and was then tested on a potential environmental stress that it was given no initial reference to. There was no validation data utilized in this paper.

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Tools and Technology:

We have leveraged the TPU (tensor processing unit) as the hardware accelerator. Python 3.7 was used to write the code for the algorithm. The model was trained on Pycharm and used the most up to date Keras and Tensorflow packages as of 12/08/21.

Results:

Figure 5 shows a knowledge graph that the software constructed by itself for a topic that it was not originally trained on: education.

Figure 4: Constructed Knowledge Graph for Diagnosing Environmental Stress from Education

Conclusion:

Our results show that our software was able to accurately learn how to construct knowledge graphs for environmental-related stress factors. However, there is some scope for improvement, as can be seen in Figure 4, with the software incorrectly relating enriching activities to happiness/stress. Interestingly, the software was able to attribute the words “Yes” and “No” without ever being explicitly told to. The next step would be to expand on the software more by introducing a larger dataset, containing a wide variety of topics from different use cases, in order

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to improve the model's use and get a more representative measure of its accuracy and room for improvements.

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