A NOVEL MACHINE LEARNING APPROACH TO ACQUIRE MEDICAL KNOWLEDGE FROM THE INTERNET AND DEVELOP COMPLEX USER INTERACTIONS

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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. In this study, a novel machine learning platform was created that could acquire medical knowledge from the Internet with regards to mental health, living habits, quality of life, standard of living, &community stress through the use of state-of-the-art natural language processing (NLP). The platform can then use said knowledge to pose unique questions about a user and give individualized responses through dynamic programming for the user's benefit. The software was demonstrated to pose a sufficient understanding of generalized medical knowledge through Internet searching and relevant questioning/understanding of the user.

Keywords: General artificial intelligence, medical knowledge, deep learning

Introduction

In this study, we considered five total areas of medical knowledge: mental health, living habits (diet, exercise, sleep), quality of life/standard of living, and community stress. All of these examples, given certain conditions, can result in positive stress and negative stress in the long-term.

Emotional, psychological, and social well-being are all part of our mental health. Mental health has an impact on the way we think, feel, and act. It also influences how human beings deal with stress, interact with people, and make good decisions. Mental health is vital at all stages of life, including childhood, teenage years, and maturity [1]. Mental health and well-being are just as vital later in life as they are at any other age. Mental and neurological illnesses account for 6.6 percent of all disability-adjusted life years (DALYs) in this age range. Approximately 15% of people aged 60 and older suffer from some form of mental illness [2].

Because human bodies and brains are not distinct, it is expected and widely supported that mental illness could have an impact on physical health [3]. An upset stomach might be caused by depression, which can cause headaches, lethargy, and digestive issues. Insomnia, restlessness, and having difficulty focusing are some of the other symptoms [3].

One of the biggest co-variants of mental and physical health is longevity. Many studies have found that those with mental health problems, such as schizophrenia(chronic brain disorder) or even depression, tend to live shorter lives than those who don't have them. The Mental Health Foundation reported that schizophrenia is associated with a tripled risk of dying from a respiratory disease and a doubled risk of dying from a form of heart disease. Depression has been associated with a 50 percent increase in a person's risk of dying from cancer and a 67 percent increase from heart disease. These conditions have a consequential impact on life expectancies [4].

Having a mental health illness might feel like an endless battle. It can be difficult to see a way out while one is coping with severe symptoms. Fortunately, as the medical community has gained greater understanding about therapies with high success rates for a variety of mental health conditions, and treatment approaches have dramatically improved in recent years.

According to one study, electroconvulsive therapy helped 85 percent of people who were severely depressed. Over a ten-year period, studies show that about 25% of people who receive schizophrenia therapy make a good recovery and 50% improve their symptoms. Nearly a third of

those who take lithium for bipolar disorder have no more episodes for ten years or longer. Treatment with cognitive behavioral therapy, for example, has been shown to be helpful [5].

Because mental diseases typically occur in families and near blood relatives, it has long been assumed that they had a hereditary foundation. The pattern of inheritance clearly suggests a single gene influence in some disorders, such as Huntington's Disease. Although there is no clear pattern of Mendelian transmission in others, such as psychoses, proof that genetic variables play a substantial role is critical. For example, according to Rosenthal's evaluation of the literature, the primary etiology of practically all schizophrenia spectrum diseases is genetic.Most of these psychiatric disorders fall into the category of complex genetic disorders, which can be explained in terms of the interaction of a small number of genes (oligogenic model), the minor involvement of many genes (polygenic model), or the involvement of environmental co-factors (polygenic model, multifactorial model). Despite considerable circumstantial evidence, the genetic basis of mental disease has not been conclusively demonstrated. Recent advancements in molecular biology have revitalized mental genetics, giving optimism for the finding of disease-related genes.

Day to day living habits such as diet, physical exercise, and rest can all positively or negatively contribute to one's longevity. Some suggestions for a healthy lifestyle are: a person should drink at least 8 cups of water per day to providing their body with adequate hydration;adults should be getting at least 7 hours of sleep, and teens should get 8-10 hours per night to allow their bodies to rest and 'recharge';meal plates should be mapped with ½ fruits/vegetables, ¼ whole grains, and ¼ protein to provide needed nutrients; and, on average, a person should engage in 150 minutes of moderate aerobic exercise or 75 minutes of vigorous aerobic exercise per week as keeping the body moving can decrease risk of some diseases [6] [7] [8] [9].

"During the last few centuries all populations may benefit from optimized nutrition to reduce incidence of obesity, type 2 diabetes mellitus (T2D), cardiovascular diseases as well as several types of cancers and infectious diseases." (Molecular Nutrition Research – The Modern Way Of Performing Nutritional Science). The article mentions how determining molecular mechanisms can offer a great potential for promoting health, and discusses ways that nutrients execute their functions. As time progressed, our molecular mechanisms have promoted the consumption of more beneficial nutrients, while also adapting to the foods that we have access to. There is a large gateway of information to be studied at a molecular level, and food intake can be a large and driving factor of a person's longevity [10].

A diet is the single most significant risk factor for disability and premature death [11]. A poor diet can result in several negative effects. Mortality rate is significantly increased with the increased consumption of red meats. High fat and sugar diets increase obesity, increase chances for diabetes and hypertension (high blood pressure), possible increased risk for Alzheimer's Disease, increased chances of getting severe tooth decay and osteoporosis, may cause colon, breast, kidney, oesophagus, gallbladder and endometrial cancers, and may lead to anxiety &depression [12].

A diet low in saturated fat, salt and sugar, and high in fruits and vegetables are part of a well-balanced diet that can help people lose weight or prevent weight gain. Vegetable consumption has been shown to correlate with income. Additionally, alcoholic drinks are empty calories (calories that do not have important nutrients), and usually increase body weight, with higher alcohol concentrations leading to higher weight gain. Some diets suggested by the American Academy of Family Physicians are the Mediterranean Diet, Dietary Approaches to Stop Hypertension Diet, 2015 Dietary Guidelines for Americans, Healthy Eating Plate, Vegetarian/Vegan Diets [13].

Getting one's recommended amount of sleep each day is beneficial for one's physical and mental health. Getting enough sleep can reduce stress and improve moods, help keep people at a healthy weight, help them think more clearly, help in promoting better reactions in social situations (and possibly decrease anxiety), lower the risk for serious health problems, including, diabetes, and heart disease. Sleep requirements by age, per 24 hours, are: Ages 6 - 12: 9 - 12 hours, Ages 13 - 18: 8 - 10 hours, Ages 18 - 60: at least 7 hours, Ages 61 - 64: 7 - 9 hours, Ages 65+: 7 - 8 hours [14].

Quality of life/standard of living is when an individual is healthy, comfortable, and able to participate in or enjoy life events. Quality of life/standard of living also involves the environment around that specific individual. When an individual meets the conditions of a high quality of life, that person generally has a happy life. If not, the person might have certain factors of their life, such as their health, their wealth, job employment, social, physical, emotional life, or education missing [15]. Although both quality of life and standard of living entail how an individual is living his or her life, they do have some key differences.

The term "quality of life" tends to be associated with an individual's values or beliefs, and other abstract concepts. For example, the freedom of speech or religious freedom are concepts that would fall into the quality of life category. The term "standard of living" usually deals with

aspects of a person's life that can be measured or quantified [16]. This often includes one's social or economic class within one's community.

The quality of life affects our longevity in numerous ways. Without certain qualities in our lives, we may get depression and stress. Furthermore, we will not be satisfied with our lives. Quality of life also affects our health. If we do not live in safe areas, or if we cannot afford medical treatments, we have an increased risk for diseases, injuries, and disabilities. The worse these problems get, the more they negatively affect our longevity. [17]

People with chronic and mental diseases have a significantly lower quality of life. It often starts when the patient is first diagnosed. Then, as the disease slowly progresses, the patient's mental health worsens. People with chronic and mental diseases can push the people they love away and can slip into depression. Even if patients get cured, they are then left with broken relationships and negative thoughts until they die. For example, over 75% of those diagnosed with high blood pressure are shown to have very low mental and physical conditions. This is because high blood pressure is often caused by stress or other things in people's lives that causes their bodies to release hormones and pump blood faster. If one is constantly stressed, one can be considered to have a bad quality of life [18].

Health problems can relate to standard of living as well. Usually, people who suffer from a low standard of living are those with addictions and other health problems. For example, those who smoke cigarettes or have an alcohol addiction often spend all of their earnings on these habits, causing them to have a reduced standard of living in other aspects of their lives. For example, in 2010 in California, more than $35 billion USD were spent on alcohol. Moreover, the cost per person was $940. This correlates with the fact that over ⅓ of California's population lives in poverty [19].

Some of the advantages of a good quality of life and standard of living include the fulfillment of basic necessities, a productive and quality education, access to healthcare services, opportunities for employment and income generation, better sanitation/a more hygienic body, better life expectancy, better literacy rates, better family opportunities in the future, access to good transportation, immediate access if any emergency happens, and good infrastructure all around.

The goal of the present project is to create machine learning-based software that can take information from diverse web-based sources and extract out relevant information regarding health and longevity to support making recommendations to people. Furthermore, the software

has to be able to learn to accommodate all of the information explicitly given to it and new incoming information found online.

Software Components

The software has to utilize several imports using Python 3.9.3 to function, all listed below:

1. Os

2. Tensorflow

3. Keras

4. Selenium

Technology/Methods

The software first starts out by having a preliminary base knowledge graph. The user then asks the software a question, to which the software checks its preliminary knowledge graph to see if the answer exists through DP. If the information to answer the question does exist in the knowledge graph, the software will utilize DP and NLP (natural language processing) to find the answer and display it in a user-friendly manner with semantics incorporated using additional machine learning. If the information does not exist in the knowledge graph, the software will venture out to the Internet to find the missing information to give a succinct answer to the user's question. The search query is first produced using generative machine learning, and then carried out with the use of Selenium. Raw text is then scraped from the websites that appear in order of relevancy, and the raw text is passed into NLP synthesizers until a correct answer is achieved through a separate ANN (artificial neural network) validator. From here, any additional knowledge extracted from the raw text of the websites is added onto the existing knowledge base in the backend via DP and machine learning. Additionally, the software was originally trained on mental health, living habits (diet, exercise, sleep), and community stress. Moreover, the software was intended to be tested on quality of life/standard of living.

Dataset

The research used a constructed dataset composed of knowledge graphs extracted from websites. In total, knowledge graphs of a depth between 50-100 were created for each separate area of medical knowledge, along with source material for the quote and query used to obtain that information.
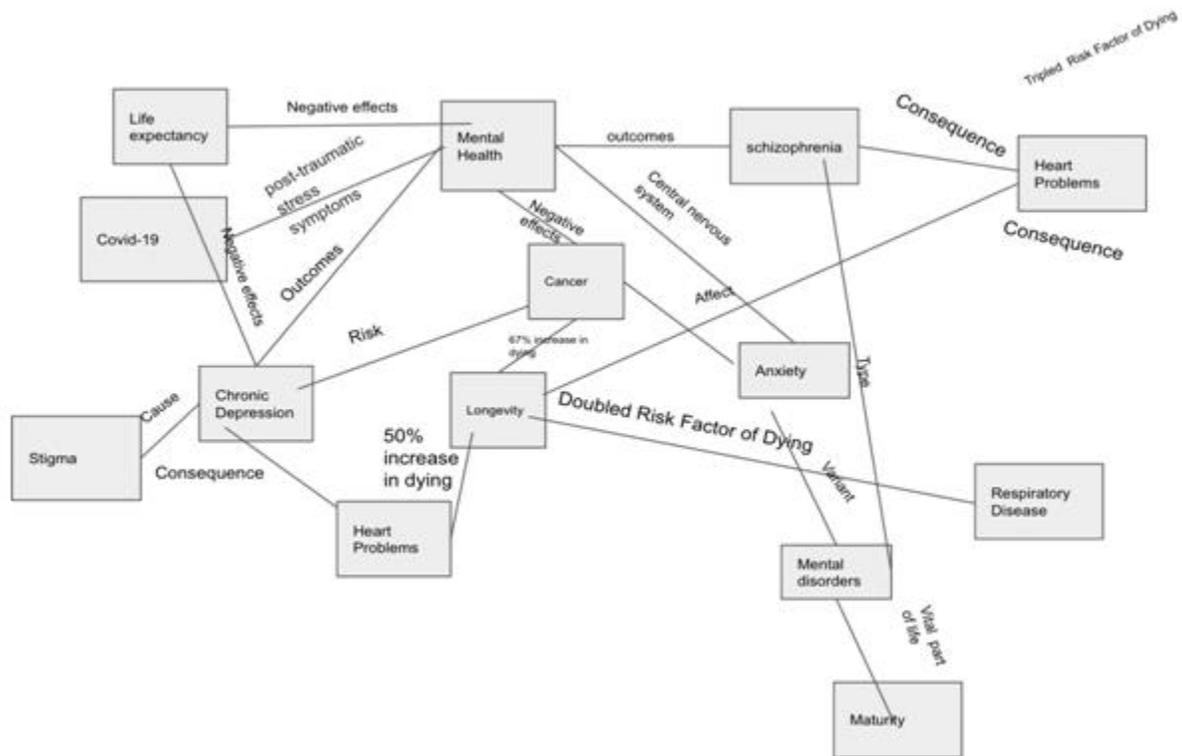
Algorithm

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) was 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 on all of its training data and was then tested on data outside of its current knowledge scope. There was no validation data utilized in this paper.

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 5/8/2022.

Results

Figure 5 shows a knowledge graph that the software constructed by itself for a topic that it was not originally trained for: standard of living and quality of life.
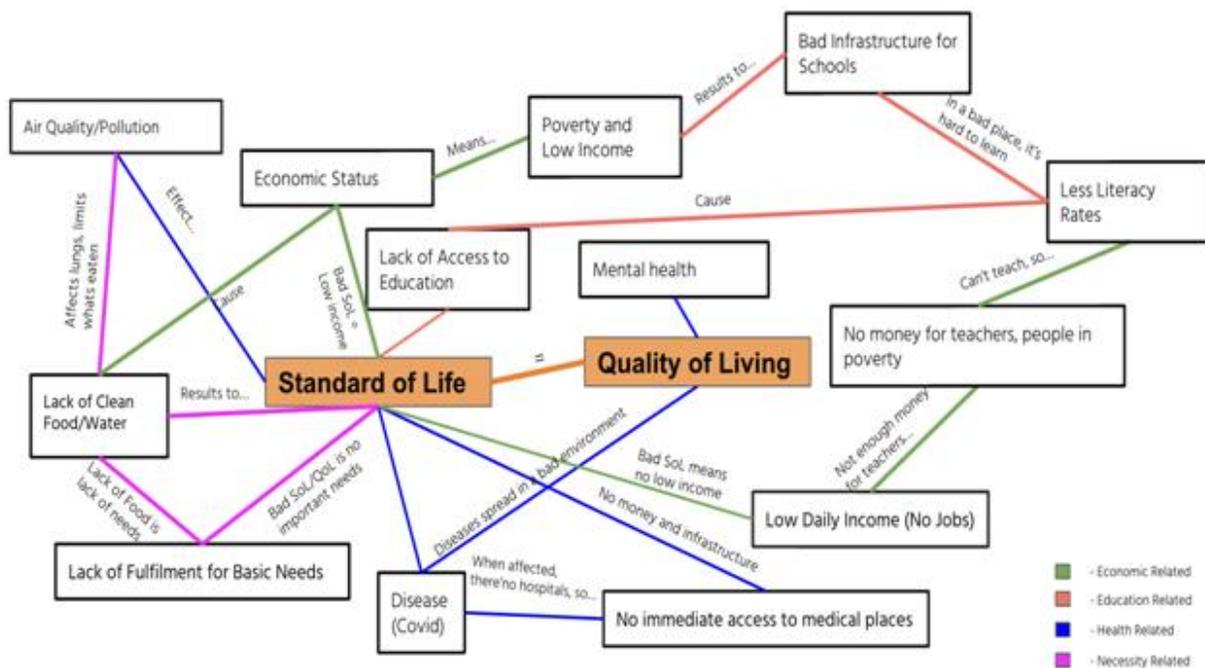
Conclusion

Our results show that our software was able to accurately learn how to construct knowledge graphs for standard of living and quality of life, which it was never explicitly trained to learn on. However, there is some scope for improvement, as can be seen in Figure 2, the software is only considering the negative impacts of standard of living&quality of life. A potential reason for this error is that there is an issue with regards to the text processing and query generation that only leads to the negative impacts being considered.The next step would be to first resolve this issue with the text processor and query generation and then also expand the software to fit a plethora

of more topics to additional depth. Potentially, knowledge tree depth could be expanded by a factor of 5, to allow for much more fact acquisition and potentially common-sense information.

References

[1]. About Mental Health. 23 Nov. 2021, https://www.cdc.gov/mentalhealth/learn/index.htm.

[2]. Mental Health of Older Adults. https://www.who.int/news-room/fact-sheets/detail/mental-health-of-older-adults. Accessed 15 Jan. 2022.

[3]. LVTDI. Accessed 16 Jan. 2022."Physical Health and Mental Health." Mental Health Foundation, 7 Aug. 2015, https://www.mentalhealth.org.uk/a-to-z/p/physical-health-and-mental-health.

[4]. "How Mental Health Affects Physical Health." Bradley University Online, 15 June 2018, https://onlinedegrees.bradley.edu/blog/how-mental-health-affects-physical-health.

[5]. Mental illness—Diagnosis and treatment—Mayo Clinic. (n.d.). Retrieved June 11, 2022, from https://www.mayoclinic.org/diseases-conditions/mental-illness/diagnosis-treatment/drc-20374974

[6]. Ekmekcioglu, Cem. "Nutrition and Longevity - From Mechanisms to Uncertainties." Critical Reviews in Food Science and Nutrition, vol. 60, no. 18, 2020, pp. 3063–82. PubMed, https://doi.org/10.1080/10408398.2019.1676698.

[7]. Mayo, C. (2020, October 14). How much water do you need to stay healthy? Mayo Clinic. Retrieved January 22, 2022, from https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/water/art-20044256#:~:text=The%20U.S.%20National%20Academies%20of

[8]. CDC. (2017, March 2). CDC - How Much Sleep Do I Need? - Sleep and Sleep Disorders. CDC. https://www.cdc.gov/sleep/about_sleep/how_much_sleep.html

[9]. How much exercise do you really need? (n.d.). Mayo Clinic. https://www.mayoclinic.org/healthy-lifestyle/fitness/expert-answers

[10]. Harvard University. (2019, January 17). Healthy Eating Plate. The Nutrition Source. https://www.hsph.harvard.edu/nutritionsource/healthy-eating-plate/

[11]. Data from major studies of premature mortality. (2015). National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK279981/

[12]. The risks of poor nutrition. (n.d.). [Text]. Retrieved June 22, 2022, from https://www.sahealth.sa.gov.au/wps/wcm/connect/Public+Content/SA+Health+Internet/Healthy +Living/Is+Your+Health+At+Risk/The+Risks+Of+Poor+Nutrition

[13]. Locke, A., Schneiderhan, J., &Zick, S. M. (2018). Diets for health: Goals and guidelines. American Family Physician, 97(11), 721–728. https://www.aafp.org/pubs/afp/issues/2018/0601/p721.html

[14]. Sleep Deprivation and Deficiency | NHLBI, NIH. (n.d.). Www.nhlbi.nih.gov. https://www.nhlbi.nih.gov/health-topics/sleep-deprivation-and-deficiency#:~:text=Sleep%20also%20supports%20healthy%20growth%20and%20development.%20Deep

[15]. Definition, measures, applications, & facts | britannica. (n.d.). Retrieved Mar 12, 2022, from https://www.britannica.com/topic/quality-of-life

[16]. Health-related quality of life and well-being | healthy people 2020. (n.d.). Retrieved June 22, 2022, from https://www.healthypeople.gov/2020/about/foundation-health-measures/Health-Related-Quality-of-Life-and-Well-Being

[17].Life expectancy & quality of life. (2017, November 15). Translational Science Benefits Model. https://translationalsciencebenefits.wustl.edu/items/life-expectancy-and-quality-of-life/

[18]. Position statement 13: Integration of mental and general health care. (n.d.). Mental Health America. Retrieved Mar 22, 2022, from https://www.mhanational.org/issues/position-statement-13-integration-mental-and-general-health-care

[19]. Data on excessive drinking | Centers for Disease Control. (2022, April 12). https://www.cdc.gov/alcohol/data-stats.htm