PREDICTION OF VACCINATION SIDE-EFFECTS USING DEEP LEARNING

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ABSTRACT

Deep learning has been very successful in the field of research which includes predictions. In this paper, one such prediction is discussed which can help to implement safe vaccination. Vaccination is very important in order to fight viral diseases such as covid-19. However, people at times have to go through unwanted side effects of the vaccinations which might often cause serious illness. Therefore, modern techniques are to be utilised for safe implementations of vaccines. In this research, Gated Recurrent Unit, GRU, which is a form of Recurrent Neural Network is used to predict whether a particular vaccine will have any side effect on a particular patient. The extracted predictions might be used before deciding whether a vaccine should be injected to a particular person or not.

KEYWORDS

Deep Learning, Gated Recurrent Unit, Recurrent Neural Network.

1. INTRODUCTION

Viral diseases have taken millions of lives over the years. Spanish Flu and Covid-19 have proven to be the darkest enemies of humanity. Not only the loss of lives, these viruses have also caused huge economic losses. Hence, the people who survived the pandemic had to face economic hardships and even famine. Vaccination is very important especially for fighting against pandemics such a covid-19. A national public health institute in the United States of America, Centers for Disease Control and Prevention (CDC), have reported that 23.3 million people have been saved worldwide since 2011 by vaccines [1]. However, the entire process of vaccination is very delicate since human life is more fragile than we think. Therefore, a single mistake might be very costly in terms of life as we have seen in the Cutter Incident back in 1955 which ended with the death of 10 children [2]. To prevent such accidents from occurring several measures have been taken. Since many delicate problems have been solved with the help of modern technologies, turning to deep learning for the prevention of such mishaps would be very ideal.

Deep learning methods such as recurrent neural networks have proved to be very efficient in terms of deriving the correct result within the shortest period of time. In most cases, they are used for the purpose of prediction. Hence, in this paper, a model is developed using a gated recurrent unit (GRU), which is a very popular form of recurrent neural network. This model is used to predict whether a certain vaccine will have any side effect on a person. This model is necessary since administering vaccines safely is a very important issue. Despite the fact that GRU is reputed to have very high accuracy while solving problems, our topic was very challenging since gathering the news of side effects are often buried by the vaccine producers to prevent the

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organisation from getting defamed. Also, because the adverse effect of a vaccine is dependent on a number of factors, including the genetic background of the person receiving the vaccine.

In this paper, the previous works in this field has been discussed in section 2. In section 3, we have explained our model that predicts the side effects of vaccines on individuals. In that section we discussed about the data that has been collected and used in this research and the variables that we included in the data to train and test the model. In the next section, section 4, we shared about the architecture that has been used. The results are shown with respect to accuracy. In section 5, future plans with this model and conclusions in section 6 has been discussed.

2. BACKGROUND

An outbreak model with the rate of nonlinear vaccination is being studied. To stop diseases various kinds of vaccination have created this vaccination to stop diseases to spread and save human lives but, in some cases, we also found that this vaccination fails to do its job moreover it creates die effect or death to the who takes the vaccine. Mankind came across various kinds of pandemics. The edge that chooses whether or not the infection ceases to exist is found. The infection free harmony around the world is stable under the limit.

The disease-free balance is unstable above the threshold, and the endemic equilibrium occurs and is asymptotically stable locally. In some particular cases, the global stability of the endemic equilibrium is demonstrated by the limiting theory and the work of the Lyapunov function. Finally, for two special cases of the rate of infection, some numerical simulations are given [3].

Immunization assumes a fundamental part in annihilating various lethal illnesses everywhere in the world. Youth immunization is a demonstrated device for controlling irresistible illnesses and is acknowledged wherever to be protected. The expanded Program on Immunization (EPI) was set up by the World Health Organization (WHO) in 1977 to give general vaccination for all youngsters by 1990. In Bangladesh, EPI was started in 1979, and this is one of the extremely effective programs in the Bangladesh wellbeing area with an inclusion rate of around 85%. Immunizations are given locally as indicated by a yearly timetable in Bangladesh which is known as miniature arrangement. At present, the inoculation plan (miniature arrangement) is created physically including around 5000 Unions and 500 Upazilas, which are regulatory units in Bangladesh. Consequently, ongoing data isn’t accessible at the focal office for checking reasons. In any case, for additional fortifying of the inclusion and compelling checking, accessibility of data is pivotal. To address this issue, the paper proposes a computerized interaction for building up the inoculation plan program through a Web-based MIS programming application. The people group well-being laborers and authorities will be ready to get to the framework through their versatile remote gadgets effectively accessible to them. The timetable and staff data will be accessible to the mid-level and focal authorities which will guarantee legitimate observing, responsibility, straightforwardness simultaneously. Subsequently, the inclusion of immunized youngsters in Bangladesh will be improved through adjusting this arrangement by the public authority [4].

Furthermore, in another paper [5], the writer sums up and dissects the stochastic Hepatitis B pandemic model with amazing inoculation and changes with massive population growth. Hepatitis B virus is one of the most serious global health issues, as we all know. Hepatitis B virus is spread through physical touch, sexual contact, by taking polluted blood or the baby can also be affected by the mother during pregnancy. From the report from WHO every year massive amounts are getting infected by Hepatitis B virus and around 600000 deaths are being caused by Hepatitis B virus. To fight over this risk, they proposed that mathematical models will be more efficient. As per their analysis, mathematical models will give more success rate. So, they started working in utilizing the stochastic differential condition with Levy leaps to consider the asymptotic conduct of the Hepatitis B pestilence model. Considering the aggregated bounce size, the edge of our plague model is explored, which decides the perseverance or annihilation of Hepatitis B. Mathematical reproductions are acquainted with the legitimacy of our outcomes.

Irresistible illness is one of the medical problems that compromise the total populace. The spread of irresistible illnesses can be controlled utilizing immunization projects and a self-detachment as proposed by the general well-being association [6] [7]. The people's motivators to take the control measures rely upon their dreadfulness of the illness. This frightfulness or a sensation of dread is related to human conduct. Thus, the goal of this study is to fuse human conduct in an infection demonstrating. Intending to contemplate the degree of dreadfulness in both sub-populations of accepting total data and getting deficient data and its effect on the immunization program. In this paper, a model is created by utilizing individual-based displays to deal with catching the human social changes during a sickness episode. The investigation of the outcomes introduced the connection between frightfulness and the inoculation of the choice of the person [8]. Henceforth, the degree of frightfulness should be inspected to sorts out a powerful inoculation program.

In another paper [9], the writers appointed out that, taking a vaccine is one of the best general wellbeing mediations, because of its security and adequacy, however, inoculation doesn't generally mean vaccination. Various angles related both to the person that gets the antibody and the explicitness of every immunization controlled are important for the way toward acquiring satisfactory vaccination, and it is fundamental to notice the perspectives to stay away from antibody disappointments. The examination of immunogenicity and adequacy reads for the measles, varicella, and mumps immunizations highlight the need to join two portions into the fundamental inoculation schedules to control these infections [10]. Epidemiological investigations that examined flare-ups of these infections distinguished cases in people that got two portions of the antibody, which may demonstrate likely auxiliary disappointment. For the yellow fever antibody, the current conversation lies in the ideal number of dosages for singular security. Notwithstanding a couple of reports in the writing concerning antibody disappointments, immunogenicity contemplates exhibit winding down security throughout the long term, predominantly in the paediatric age section [11]. In the flow situation of end and control of sicknesses, related with the abatement in the dissemination of the wild-type infections, the job of epidemiological reconnaissance is significant for extending information on the numerous variables included, coming full circle in immunization disappointments and the development of episodes. Flare-ups of antibody-preventable sicknesses contrarily sway the believability of inoculation programs, prompting low immunization inclusion rates and meddling in inoculation's prosperity.

3. MODEL AND IMPLEMENTATION

The model we proposed to detect side effects of vaccines consists of simple but effective steps. Below is a diagram of the proposed model that consists of the steps to be followed in the attempt to detect the side effect of vaccines.

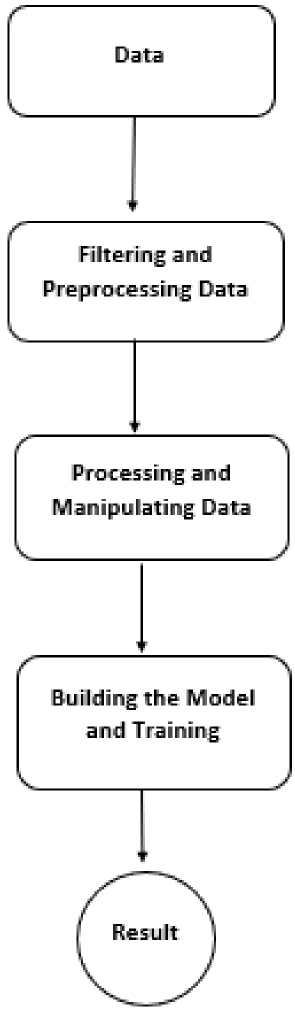

Figure 3.1. Workflow of System

At the very beginning, we collect data from several centers in the city where vaccines are being administered. Because of the movement limitations and other restrictions imposed during the pandemic for the sake of safety and preventing the virus from spreading, the data acquired is relatively limited. The data is then pre-processed, processed and manipulated according to our needs. The data we used consisted of two variables. The variables that we used for this model are Diabetes and Cardiovascular Diseases. These two variables were used because it is prominent among the population of the world. So, more data was available that included these factors. Furthermore, these variables have proven to have the most significant effects on people who had vaccines administered. However, these aren't the only factors that can influence vaccine effectiveness. Below we have provided a glimpse of the data that we have collected and used to this research.

	names	age	heart-conditions	diabetes	side-effect
0	md. nayeemur rahman khan	42	0	1	0
1	khandokar yasmeen	45	1	1	0
2	fatema ali	56	1	1	0
3	md. shakil	41	0	0	0
4	syeeda shamoli rahman	47	0	1	0
...	...	...	...	...	...
104	orpa islam jumka	47	1	1	0
105	doyel islam mehbuba	41	0	1	0
106	redoan rony	44	1	1	1
107	tanveer hasan rubel	43	1	1	0
108	veronica gomez	61	0	0	0

109 rows × 5 columns

Figure 3.2. Glimpse of the dataset.

As we have mentioned above, two very serious variables for the side effects are being considered in the paper, which are diabetes and cardiovascular diseases. We have found that a large portion of the people who have been administered the vaccines have diabetes. Below we have provided a bar chart generated from the data we have gathered comparing the number of people who have diabetes to those who do not, from the people who got the vaccines administered.

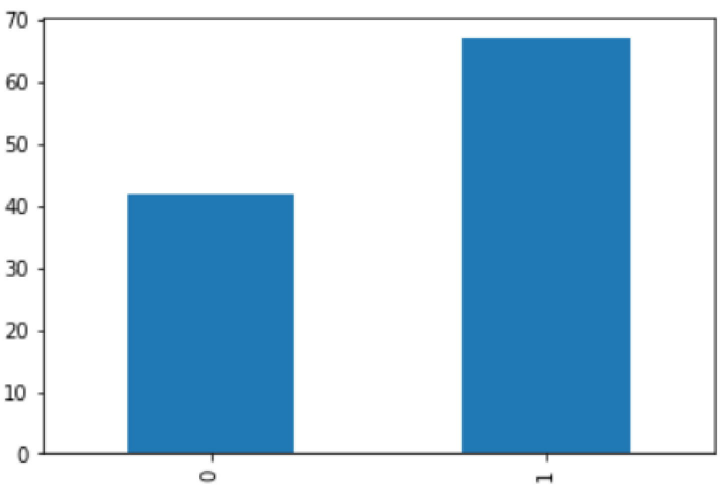

Figure 3.3. Comparison between number of people having and not having Diabetes.

We also discovered that half of those who received the vaccinations had cardiovascular illness. Another bar chart has been created that compares the number of people with cardiac issues to those who have not, among those who have received immunizations.

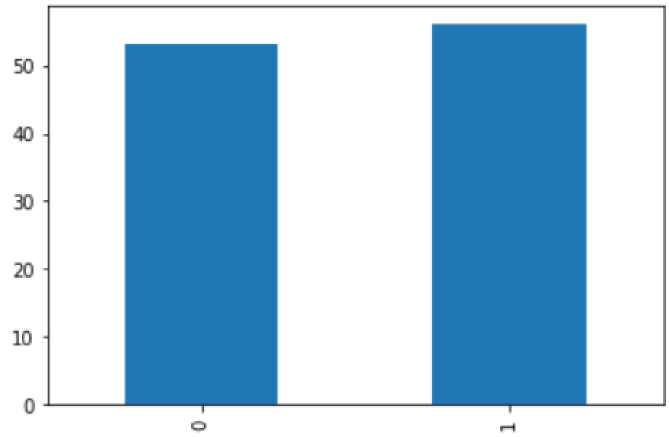

Figure 3.4. Comparison between number of people having and not having Heart Disease.

This is mainly because at the time of the data collection only the elderly citizens were being vaccinated, who were prone to either one or both the conditions. And very less people had none of the conditions. Below we have generated another bar chart comparing the number of people have any of the two conditions to those who have none.

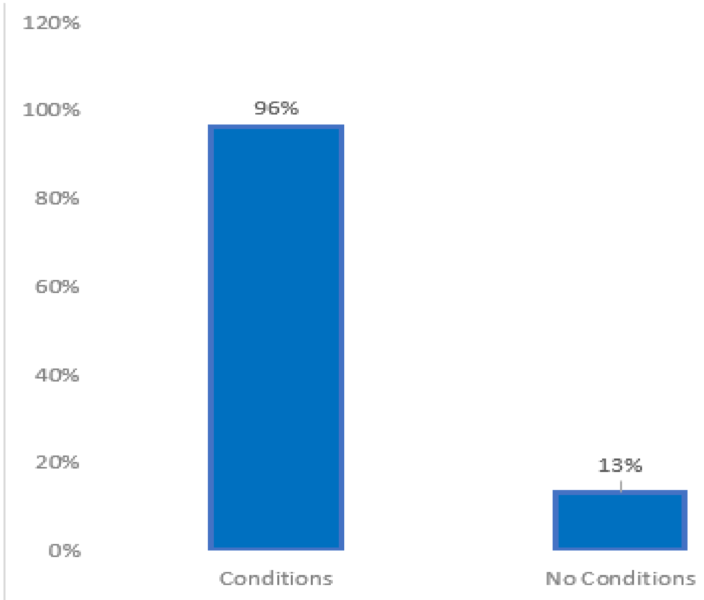

Figure 3.5. Comparison between number of people having condition and who having none.

Finally, we looked at how many persons experienced side effects or other forms of discomfort after receiving the vaccines.

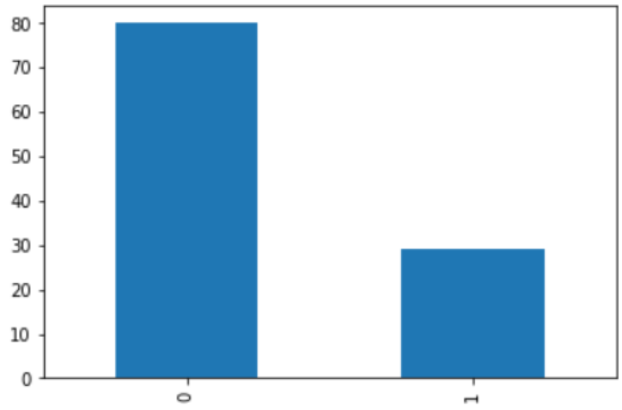

Figure 3.6. Comparison between number of people having and not having Side-effects.

4. RESULTS

The processed data is then put inside an Artificial Neural Network model. Several models of ANN have been tested to find the one that gives us the optimum accuracy with the given set of data. Recurrent neural networks such as LSTM [12] and GRU showed results with higher accuracy. The GRU model was then selected due to having the highest accuracy. The GRU and the other models were trained with 80 percent of the data and tested with the remaining 20 percent. The models predict whether a vaccine when administered will have any effect on the person or not. The result of the trained ANN is given in the table below.

Table 4.1. Model vs Accuracy

Model	Accuracy
GRU	83%
RNN	79%
Logistics Regression	73%

The graphical form of the table is being shown for better visualisation of the accuracy of each of the models which were trained for this research.

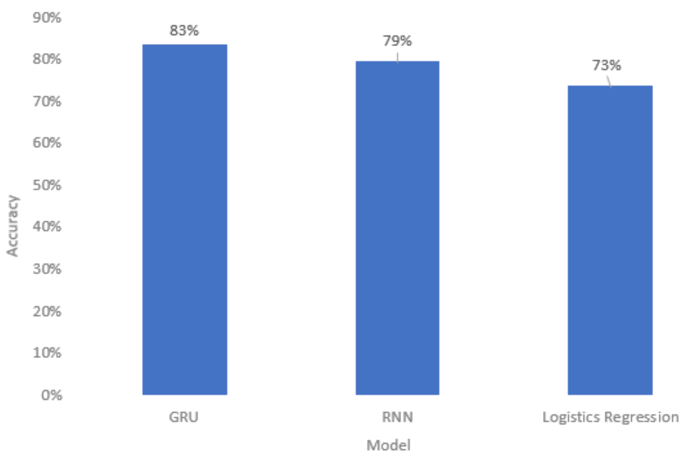

Figure 4.1. Graph of Model vs Accuracy

The GRU model is a small Artificial Neural Network model from the Recurrent Neural Network family which is very similar to that of the LSTM architecture. The details of only this model is explained below since we are focusing on the model with the highest accuracy.

This model is a linear stack of layers and has been built with an instance of the sequential class. The first layer of this model is the embedding layer which receives as input an integer matrix of size (32,50). This layer gives an output of shape (*, 50, 32). A GRU layer has been added followed by this. The GRU layer has 100 units, which proved to be sufficient enough for the purpose of producing a better accuracy than the LSTM layer. The unit of the GRU layer was determined on a trial-and-error basis. The final layer added to this small but efficient model was the dense layer. The layer had a sigmoid activation argument passed to it. The output from this layer is an array of shape (*,6). This model had no dropout layer unlike most LSTM models. [13].

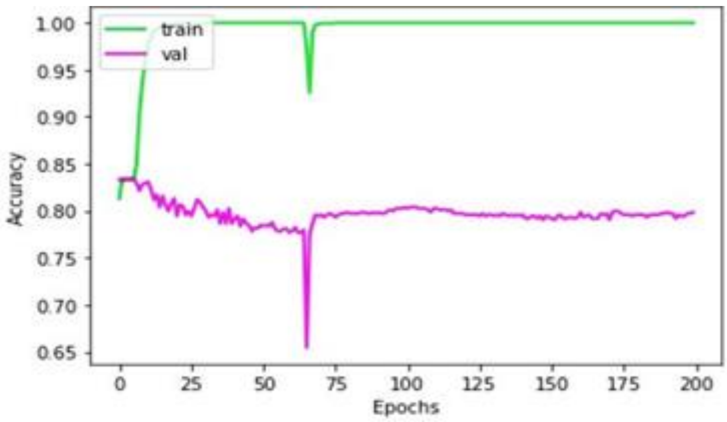

Figure 4.2. Graphical View of Accuracy

5. FUTURE PLAN

Through this paper we tried establishing the point that neural networks can be used to predict ill effects of vaccines on individuals. Our goal for the future is to collect more first-hand data, if possible, which would reduce the amount of over-fitting that might have happened during this research, and to include more variables that would make the model more reliable. It is expected that as the vaccine roll-out ramps up in different country, we would be able to differentiate the different demographic variables, which would enhance the research. We would also like to try out different variations of neural networks to figure out which one would serve our purpose the best. For better research purposes we could also segment the data based on area, ethnicity, etc. This would not only make healthcare more advanced but also ensure the safe administration of vaccines, helping us to fight against different lethal microbes in the future.

6. CONCLUSIONS

Predicting whether a vaccine would have any particular side effect when administered on a person is very important since there are a lot of viruses which present the vulnerability of mankind and its existence. This will not only help us to achieve the trust of the mass population who are scared of side effects but will also move towards a more immune world. However, this is one of the very first models to predict such a thing. This model needs to be redefined over the time so achieve better accuracy with more variables included, since there are a lot of variables that need to be kept in mind. As we have mentioned above, in this model we only took two variables into account, diabetes and CVD, but in a real-world scenario a person maybe exposed to other health issues as well. We hope our research would bring out the best possible results for the achieving the herd immunity which is very vital for out battles against pandemics which we have faced time and again.

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