Deep Learning Model for the Prediction of Covid-19

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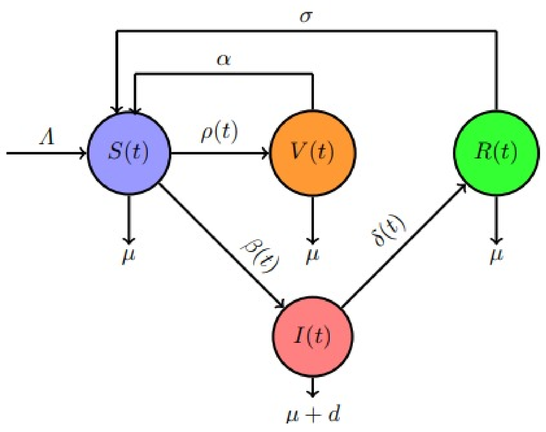
Abstract

Covid-19 is an infectious disease caused by a strain of Coronavirus called SARCOV-2. This disease started in China on November 16, 2019 in Wuhan in Hubei province and was declared by the World Health Organization as a state of emergency on March 11, 2020. This epidemic started in Cameroon on March 14, 2020 in the far north region and up to our the whole world has experienced over 650 million confirmed cases with over 7 million deaths. In this research work, we study the prediction and prevention of COVID-19 in Cameroon using deep learning combined with a mathematical model that describes the spread of the disease. We first establish a mathematical model that describes the transmission of COVID-19 within the Cameroonian population with certain parameters that depend on time and other constants that have known or estimated values. Second we establish two deep learning models namely an LSTM which means in long short term memory and a GRU which means closed recurrent unit and then we make the prediction of the time dependent parameters thanks to the daily data that we have and during of the evaluation we obtain better scores with the coefficient of determination which is between 0.97 and 0.99.

1. Introduction

The world has known so far several types of event such as natural disasters. Since antiquity many of them have had to mark history. Up to the current COVID-19 declared on March 11, 2020 by the WHO as a pandemic. It started in Wuhan at the end of December 2019 in China in the province of Hubei. Coronavirus disease is an infectious disease caused by a new virus (SARS-COV2) belonging to the beta coronavirus family. It is mainly spread by contact with an infected person. Until today there is no official measure to avoid contracting this disease and its spread is fast and controlling it becomes a difficult task. Therefore, the question arises as to how can Deep Learning help us predict and prevent Covid-19? To answer this question we build a mathematical model of the transmission of COVID-19 and then a deep learning model.

3. Tools and Methods



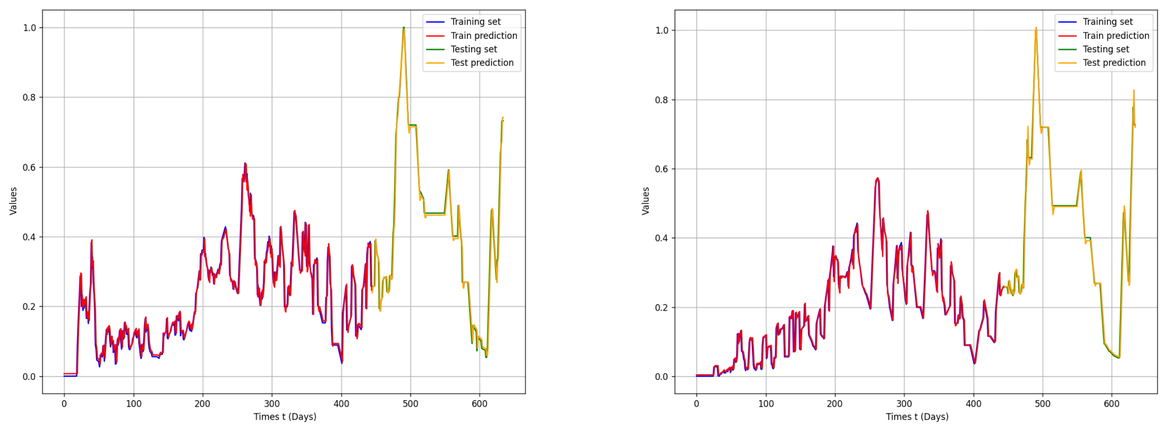
- When $I(t) = 0$ we have: $\beta(t) = \delta(t) = 0$.

So we can summarize these expressions for estimating the parameters of our dependent model as follows:

* If $I(t) \neq 0$:

$$\begin{cases} \rho(t) = \dfrac{V(t+1) - V(t) + (\mu+\alpha)V(t)}{S(t)}, \\ \beta(t) = \dfrac{I(t+1) - I(t) + R(t+1) - R(t)}{S(t)I(t)} \times N(t) \\ \qquad + \dfrac{(\mu+\sigma)R(t) + (\mu+d)I(t)}{S(t)I(t)} \times N(t), \\ \delta(t) = \dfrac{R(t+1) - R(t) + (\mu+\sigma)R(t)}{I(t)}. \end{cases}$$

4. Deep Learning Model



The two curves above represent the training and testing of our model using real data from Cameroon. On the left we have the rate of transmission of the disease which evolves over time and on the right we have the daily recovered rate as well.

Beta	**Evaluations metrics values**			
Method	**mse**	**rmse**	**nrmse**	$\mathbf{R}^2$
LSTM	0.000826	0.028749	0.112435	0.982225

These different metrics that our train well and test well for our beta transmission rate.

Delta	**Evaluations metrics values**			
Methods	**mse**	**rmse**	**nrmse**	$\mathbf{R}^2$
LSTM	0.000826	0.0287499	0.112435	0.977750

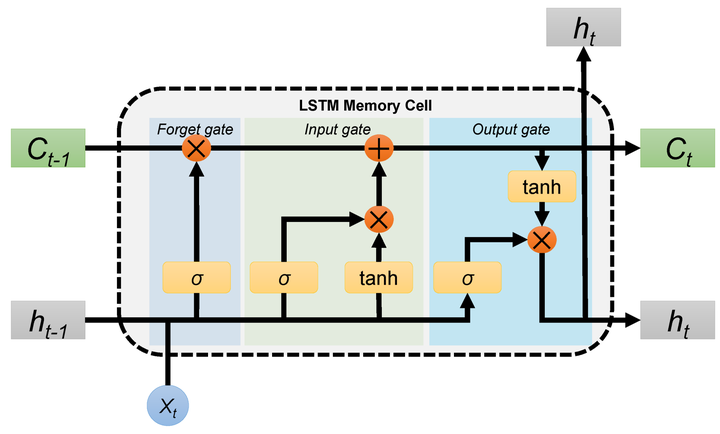
These different metrics that our train well and test well for our delta recovered rate.

2. Method

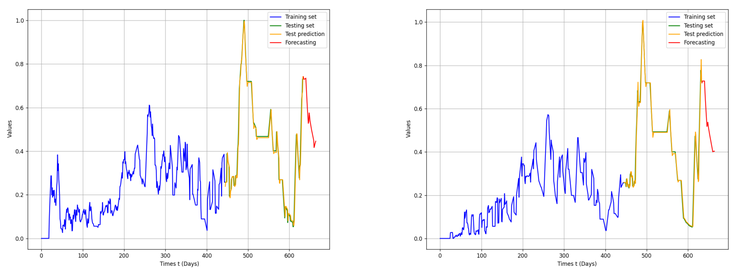
1. Data acquisition.
2. Construction of a mathematical model of the transmission of Covid.
3. Estimation of different time-dependent parameters in order to construct new data.
4. Construction of Deep Learning Model (Long Short Term Memory).

3. Tools and Methods

1. Dataset
   Data: $\{\beta(t), \delta(t), \rho(t);\ 0 \leq t \leq T-1\}$.
   After estimating the parameters of the model, these parameters are used as prediction targets of the deep learning method. These parameters are organized in time series where w = size of the time windows of the input time series data in the deep learning model.
2. Splitting the Dataset
   70% for training (444) and 30% for testing (191).
3. LSTM Architecture



5. Forecasting over 30 days and Conclusion



In conclusion, it was a question here of predicting and preventing Covid-19 using deep learning, we studied the rate of transmission and cure of the disease and we have good results in the training and validation of the model and so in the forecasts over the next 30 days we find that the different decrease and grow slowly, however, from which we conclude that the disease is still present in Cameroon and is gradually disappearing, hence the need to always respect the barrier measures.

References

[1]. *"Coronavirus: WHO warns of the risk of a "pandemic"" [archive], on RTL.fr.*
[2]. *Bhardwaj and Wei. Deep Learning Essentials: Your hands-on guide to the fundamentals of deep learning and neural network modeling. (2018).*