PREDICTION OF COVID-19 CONTAGION INTENSITY IN CHICAGO, IL.

By Mutuyimana Manzi

INTRODUCTION

- Prediction of the continuous values of COVID-19 contagion intensity in Chicago, IL
- Utilization of preexisting data that is not specific to pathogenic properties of COVID-19
- Utilization of swish, softplus, ReLU and leaky ReLU as activation functions
- Solving the issue of vanishing gradient descent and local minima or maxima

Data

- Data collection with:
  - Economy, society, health, and environment properties as features
  - Web scraping
  - API requests
  - wget() download
- Data processing with:
  - String editing
  - Geographical location assignment
  - Datapoint rescaling
- Data organization with:
  - Chicago's Zip code area
  - Zip code area reassignment from community area
  - Calculation to the percent scale

Methodology : The Target Variable

$$h_{j,t} = \frac{\beta_t S_{j,t}\, 1 - e^{\left(-\sum_k m^t_{j,k} X_{k,t} Y_{j,t}\right)}}{1 + \beta_t Y_{j,t}}$$

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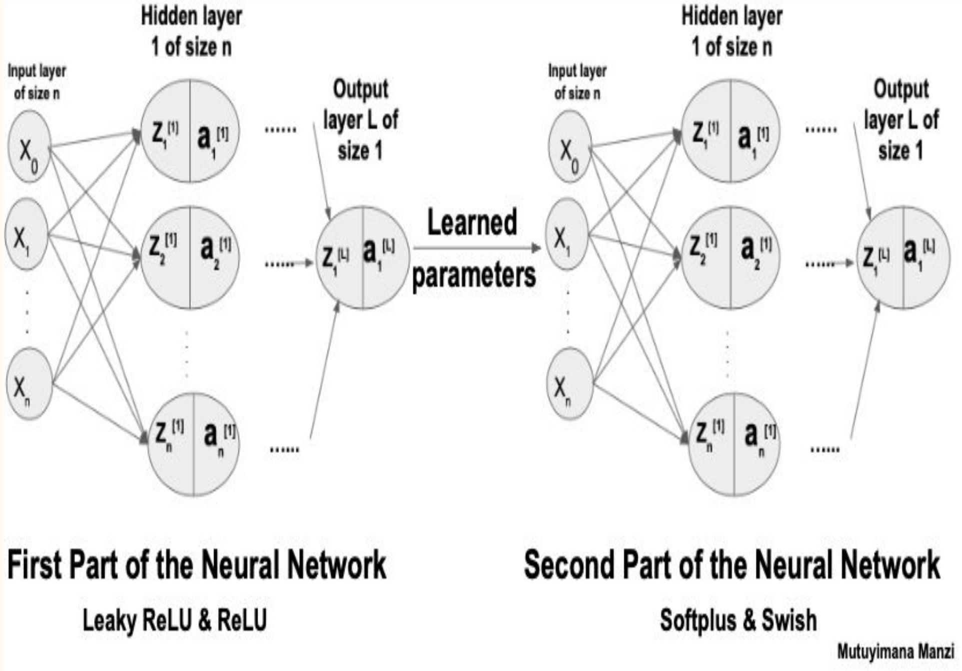
- From SIR Model to the continuous values of the COVID-19 contagion intensity
- Calculation of the COVID-19 contagion intensity per Chicago's zip code area

Methodology: Neural Network Model



- Two-part deep neural network
- Activation functions in Part I:
    - ReLU and leaky ReLU
- Activation functions in Part II
    - Swish and Softplus

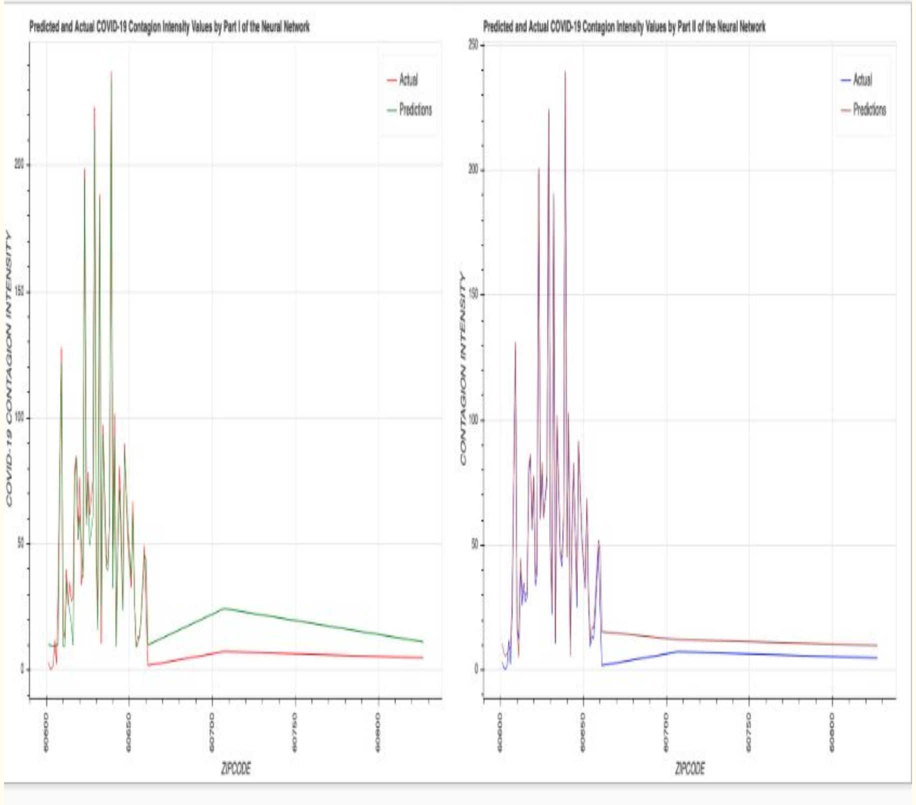
$$f(x) = \frac{x}{1 + e^{-\beta x}}$$

$$f(x) = ln(1 + e^{x})$$

$$f(x) = max(1, x)$$

$$f(x) = max(0.01x, x)$$

Results : Prediction



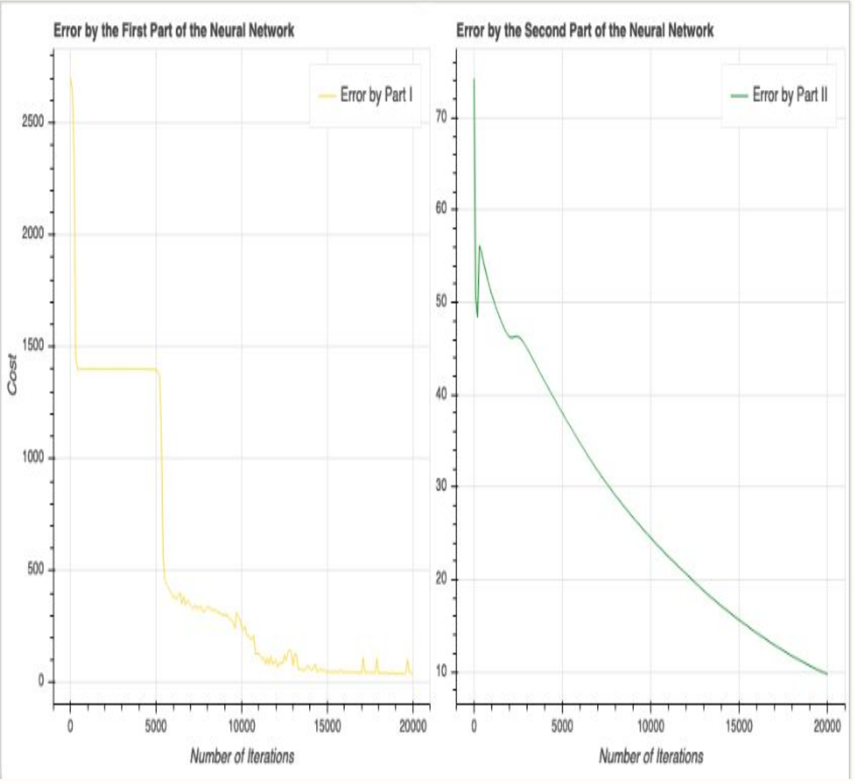
Part I:

- R-Squared from the first part of the neural network is 0.973

Part II

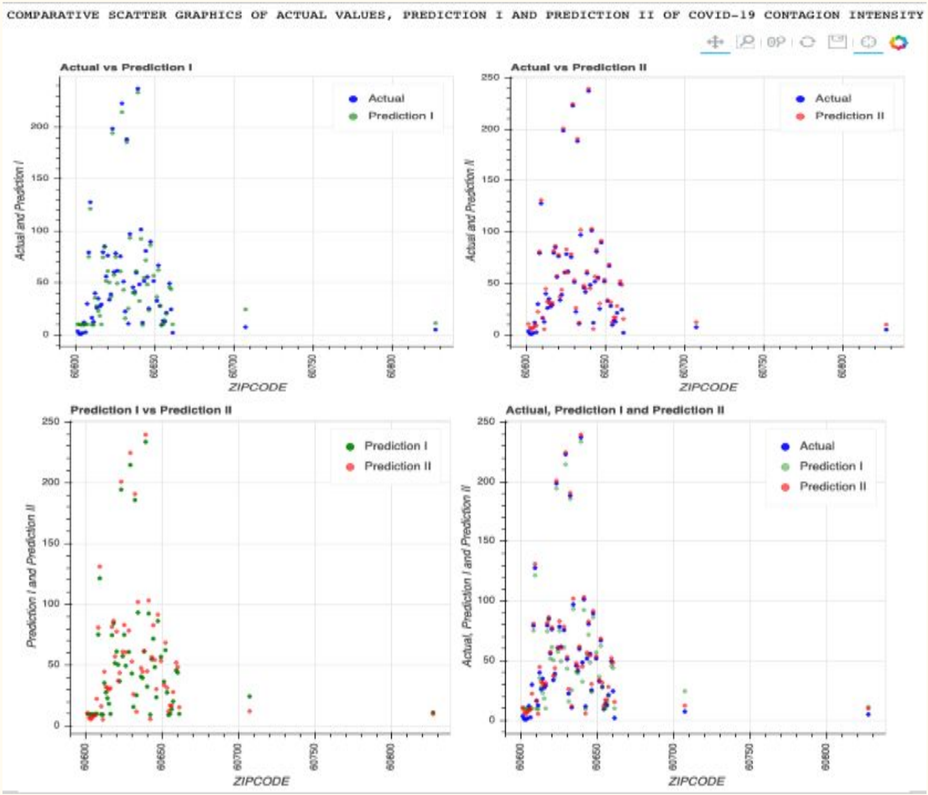
- Coefficient of determination from the second part of the neural network is 0.993

Results: Mean Squared Error



- Part I:
  - At the beginning of training MSE is 2698.535
  - At the end of training MSE is 37.443
- Part II
  - At the beginning of training MSE is 74.250
  - At the end of training MSE is 9.747

Results : Vanishing Gradient Descent & Local Minima/Maxima



Part I:

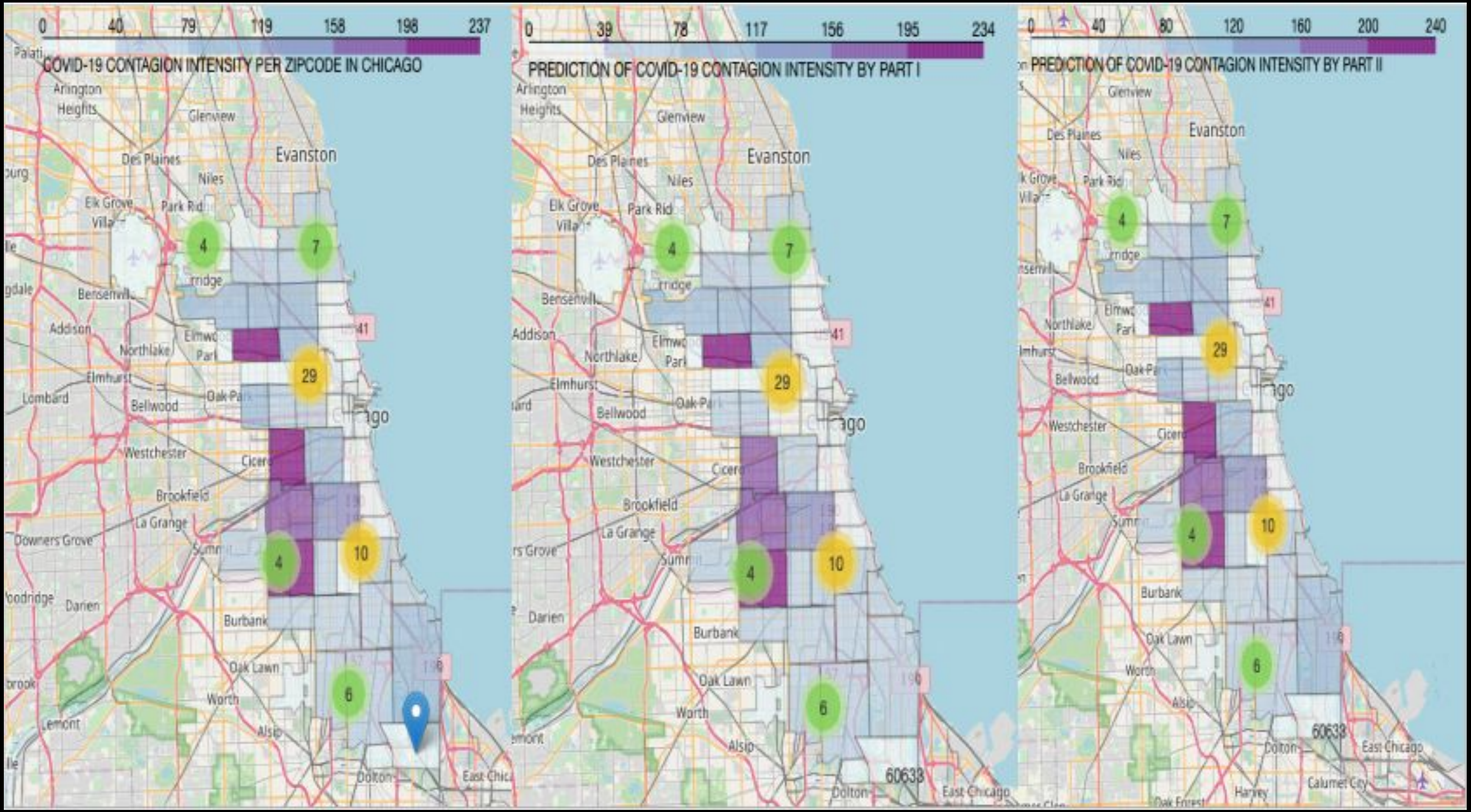
- Local minimum encountered at MSE value 1409.12
- 4,600 iterations to overcome the local minimum

Part II:

- Vanishing gradient descent encountered at at iteration 200,
- MSE increases from 49.2 to 56.07

Conclusion

The neural network model with activation functions of ReLU and leaky ReLU, Swish and Softplus efficiently predicts continuous values and overcomes the issue of vanishing gradient descent and local minima or maxima. With this project only limited on the level of zip code areas of the City of Chicago, the identical technique could extrapolated on a much larger scale, such as the national level to make predictions of contagion intensity.


0 40 79 119 158 198 237
COVID-19 CONTAGION INTENSITY PER ZIPCODE IN CHICAGO
0 39 78 117 156 195 234
PREDICTION OF COVID-19 CONTAGION INTENSITY BY PART I
0 40 80 120 160 200 240
PREDICTION OF COVID-19 CONTAGION INTENSITY BY PART II
60633
60633