Neural Ordinary Differential Recurrent Network for Learning Continuous Time Series

Author: Mansura HABIBA

Supervisor: Professor Barak PEARLMUTTER

May 23, 2019
ABSTRACT

Neural ordinary differential equations is relatively a new research area where ordinary differential equation is used to model a network as a continuous function instead of a series of layer. Traditional neural network is a series of layers. This model computes the continuous dynamics of hidden units using an ordinary differential equation solver, therefore, the model can be described as a continuous function. This new type of neural network provides faster testing time than recurrent network, however the training time is slower. This kind of neural network can be computed at accurate time with less parameters as well as constant memory cost. This kind of model does not require to back propagate through the operations of the solver, instead an ordinary solver is used to compute the state at any time t and help the gradient to train itself with marginal budget cost.

This PhD thesis aims to answer the following core questions: (a) Can ODE based deep neural network overcome the limitations of missing patterns in continuous time series learning? (b) Can the two widely used recurrent neural network e.g. GRU / LSTM can be modelled using ordinary differential based deep neural network? (c) Can ODE based deep neural network solve the following problems of deep neural network (i) irregular sampling rate (ii) short time steps and (iii) high sampling frequencies. This work would have a significant contribution to leverage the functionality of ODE solver in deep learning.

To achieve this goal, in this work, the input from event-based sensors would turn to asynchronous output, the process would be more data driven as the time stepping would be more accurate and dynamic. This would also help to process temporal sequences could be also used for time-stepped models. This proposed work would also contribute extensively in understanding other similar continuous temporal sequence-based process.