

**3<sup>RD</sup> INTERNATIONAL CONFERENCE  
ON ADVANCES IN COMPUTING AND DATA SCIENCES  
(ICACDS 2019) APRIL 12-13, 2019**

# **Convolutional feature extraction and Neural Arithmetic Logic Units for Stock Prediction**

Shangeth Rajaa

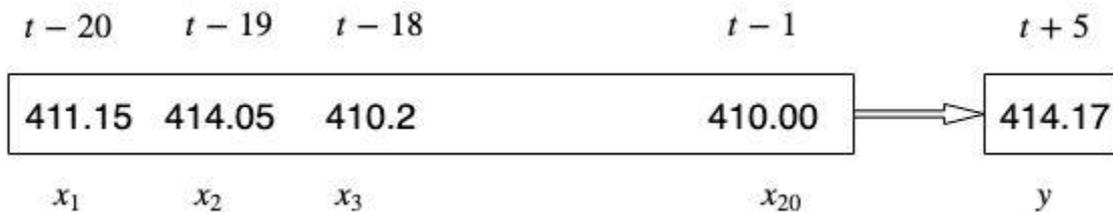
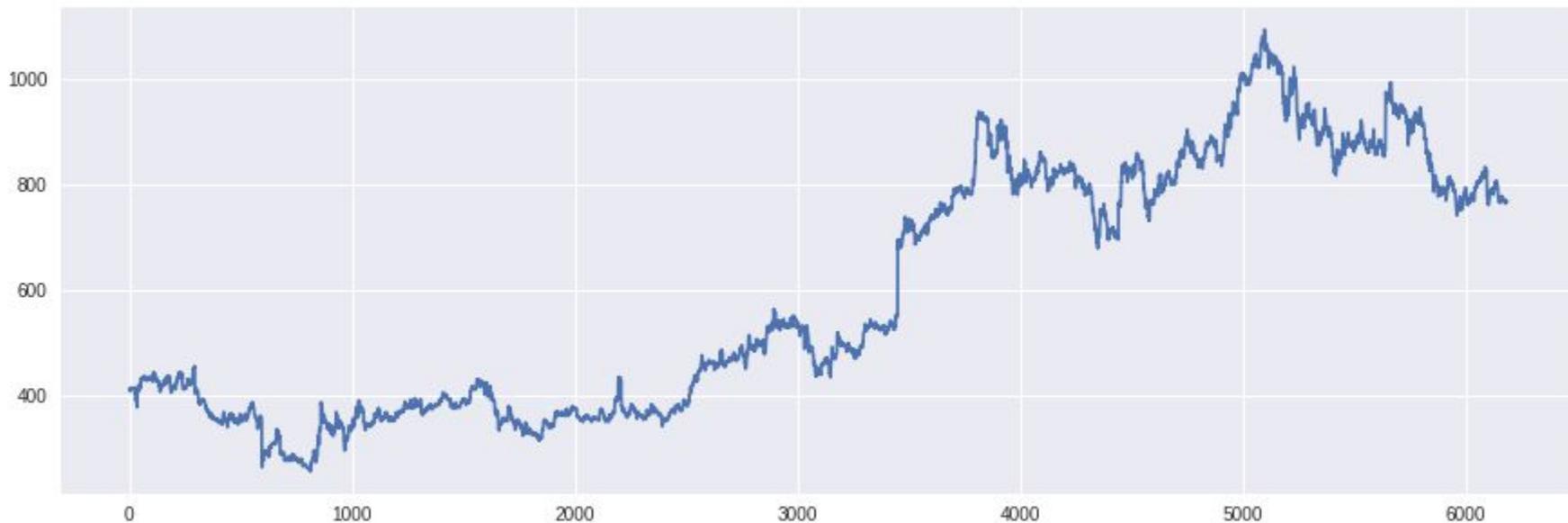
Jajati Keshari Sahoo

Department of Mathematics, BITS Pilani Goa Campus



# Introduction

## Stock Prediction as a Pattern Recognition Task



# Deep learning in Stock Prediction

## Artificial Neural Network

$$h_1 = \phi(X \cdot W_1 + b_1)$$

$$h_i = \phi(h_{i-1} \cdot W_i + b_i)$$

$$\hat{y} = \phi(h_n \cdot W_n + b_n)$$

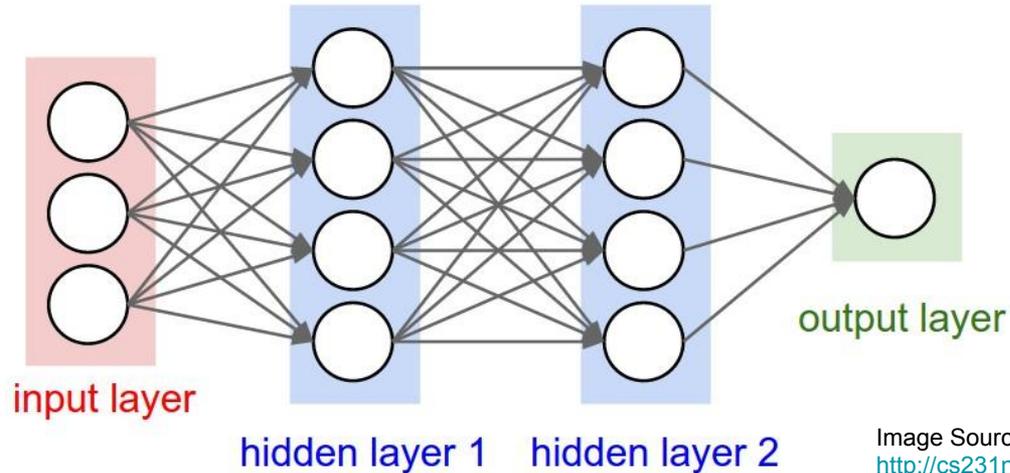
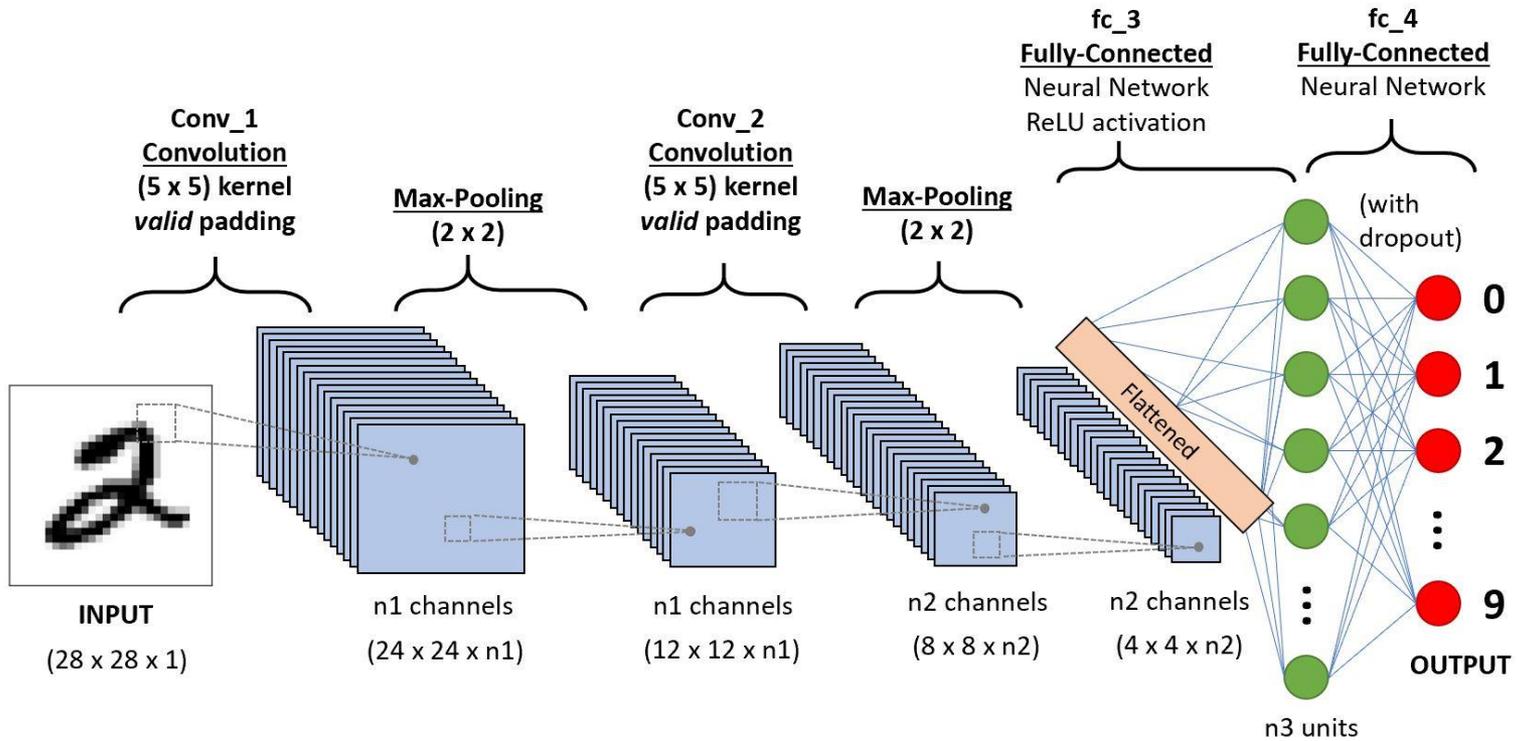


Image Source :  
<http://cs231n.github.io/convolutional-networks>

# Convolutional Neural Network



# 1D Convolutional Neural Network

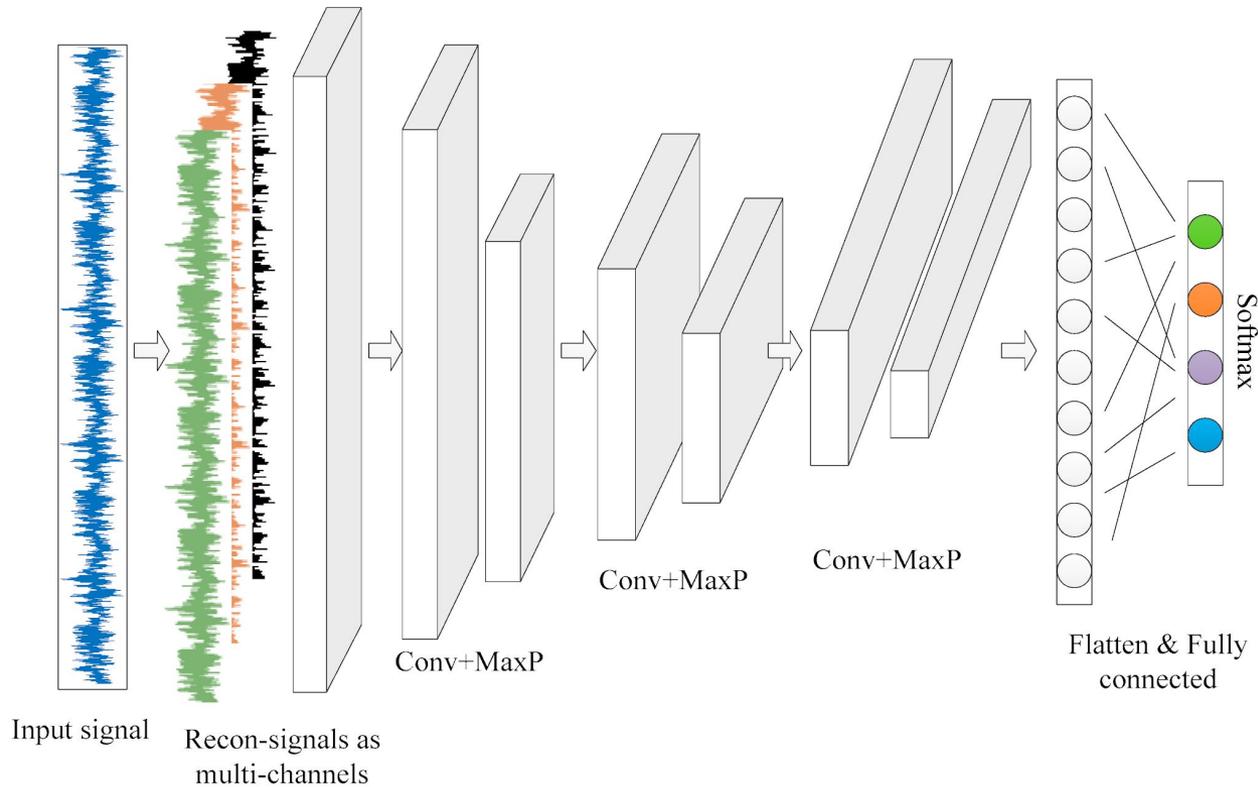


Image Source : A Self-Adaptive 1D Convolutional Neural Network for Flight-State Identification

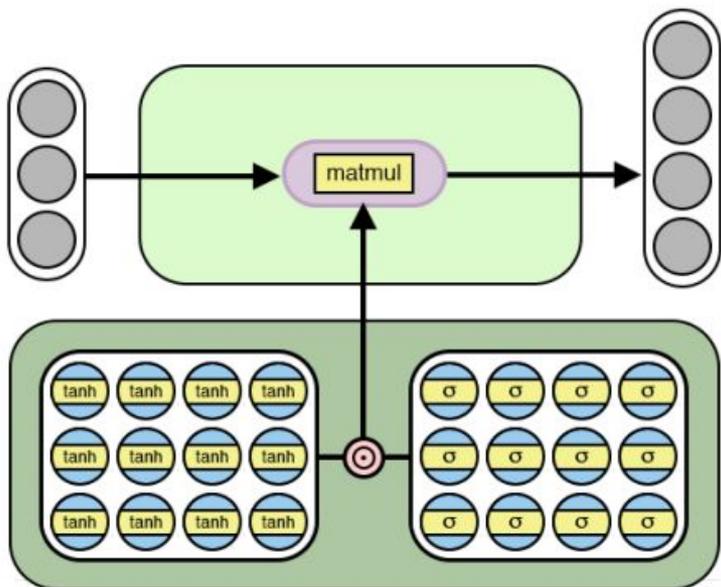
# Disability of neural networks beyond training data space

- Neural Networks can't generalize beyond the training data space.
- This disability leads to memorization of data space than generalization.
- They can't extrapolate numeric data outside the training data space.

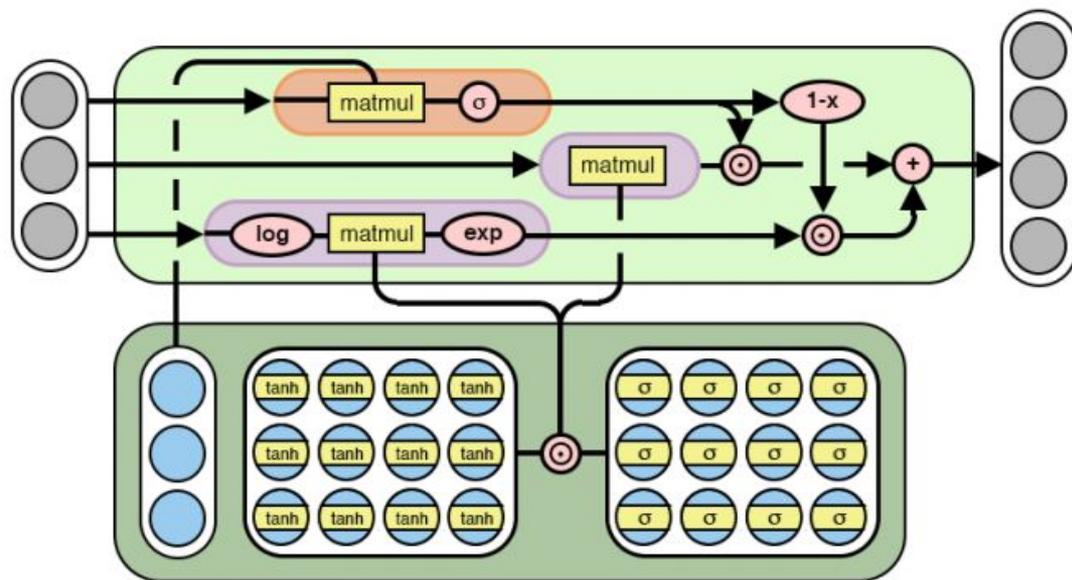
# Neural Arithmetic Logic Units

Paper : <https://arxiv.org/pdf/1808.00508v1.pdf>

Authors : Andrew Trask, Felix Hill, Scott Reed, Jack Rae



(a) Neural Accumulator (NAC)



(b) Neural Arithmetic Logic Unit (NALU)

$$a = Wx$$

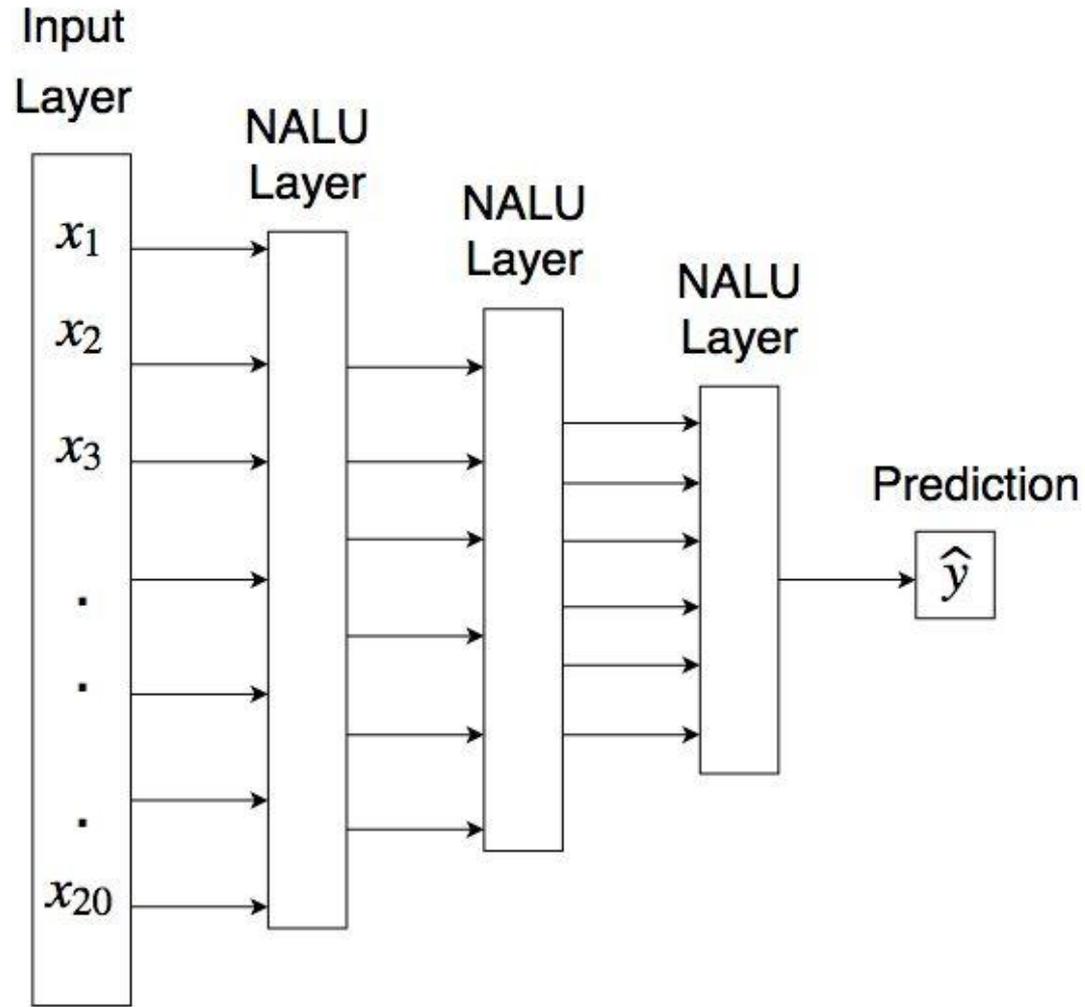
$$W = \tanh(\hat{W}) * \sigma(\hat{M})$$

$$y = g * a + (1 - g) * m$$

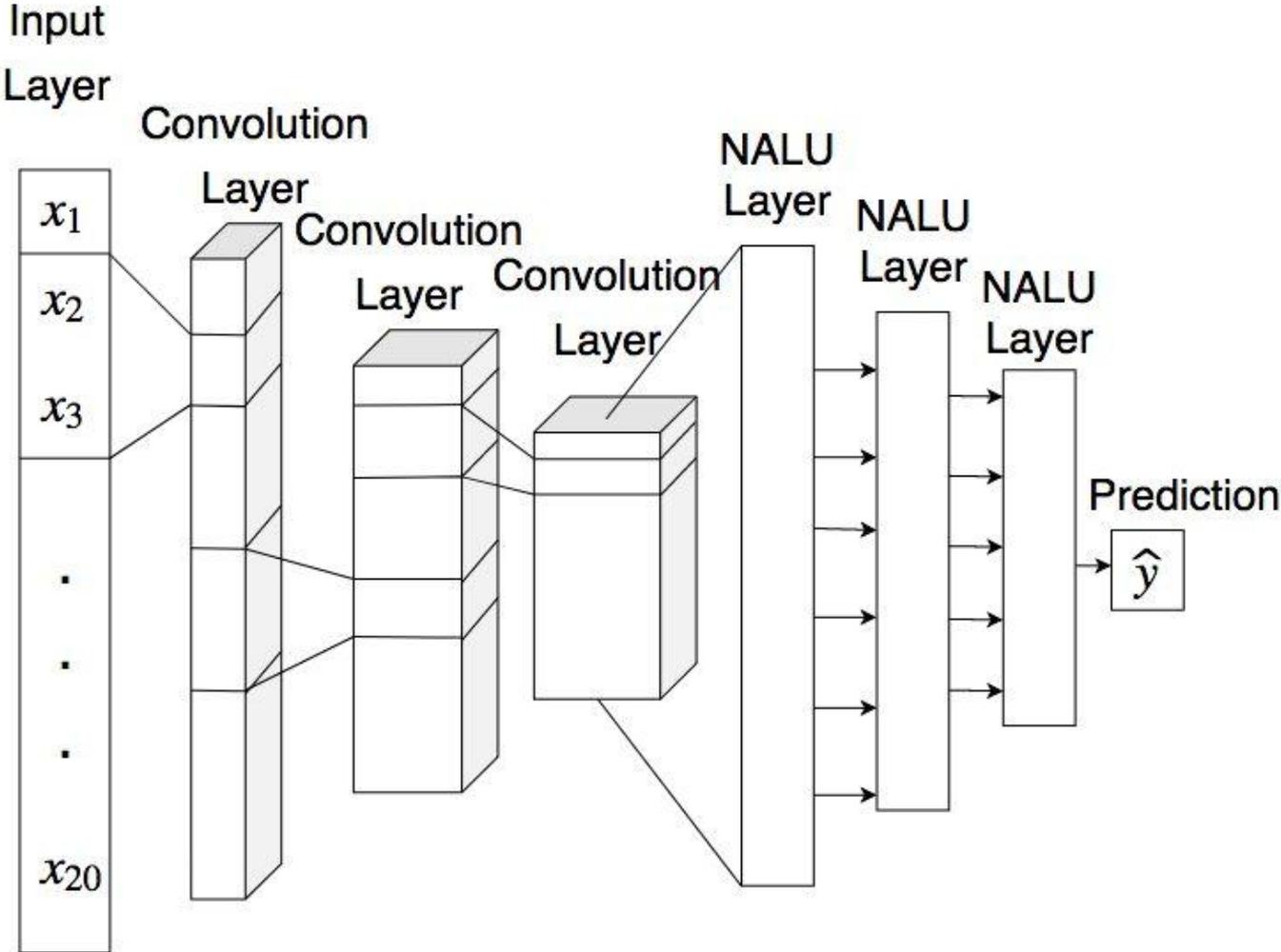
$$m = \sigma(W(\log(|x| + \epsilon)))$$

$$g = \sigma(Gx)$$

# NALU Network



# CNN-NALU Network



# Training and Results

- Data scaled with Min-Max Scalar to range  $[0, 1]$  for better convergence.
- Suitable activation functions such as ReLU and Sigmoid are used to make the model non-linear and complex.
- $MSELoss(y, \hat{y}) = 1/m \sum_{i=1}^m (y^{(i)} - \hat{y}^{(i)})^2$
- Adam optimizer with Cyclic Learning rate Scheduler.

**Table 2.** Training Loss of Models

<b>Model</b>	<b>Training Loss</b>
Artificial Neural Network(ANN)	8.04649e-06
Convolutional Neural Network(CNN)	5.58822e-06
Neural Arithmetic Logic Units Network(NALU)	1.91356e-06
NALU CNN Network(NALU-CNN)	5.58499e-07

**Table 3.** Testing loss of Models

<b>Model</b>	<b>Testing Loss</b>
Artificial Neural Network(ANN)	1.30709e-06
Convolutional Neural Network(CNN)	5.99638e-07
Neural Arithmetic Logic Units Network(NALU)	4.31875e-07
NALU CNN Network(NALU-CNN)	3.05196e-07

**Table 4.** Loss of Models in the whole data set

<b>Model</b>	<b>Total Loss</b>
Artificial Neural Network(ANN)	1.29998e-06
Convolutional Neural Network(CNN)	1.07971e-06
Neural Arithmetic Logic Units Network(NALU)	3.97540e-07
NALU CNN Network(NALU-CNN)	3.30627e-07

# Artificial Neural Network



# 1D Convolutional Neural Network



# NALU Network



# CNN-NALU Network



Questions?