EE1390 INTRODUCTION TO AI and ML

Mathematical Understanding behind Toy Car Model

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Problem Statement

Our goal is to Understand maths behind the AI toy car model

Recurrent Neural Network

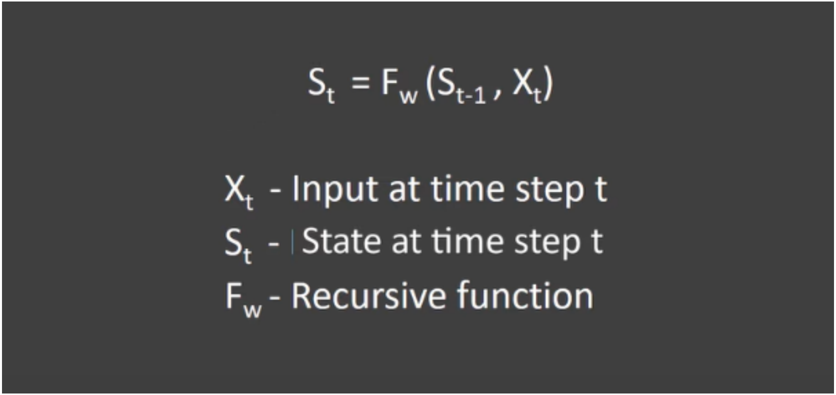
RNN are types of neural networks designed for capturing information from sequences/ time series data.

Recurrent Neural Network

In our Model, after performing the MFCC on the input sound we get an output matrix of 49x39 i.e. 49 time steps with each having 39 features where the correlation between the time steps can be exploited for the classification of the sound to one of classes.

Recurrent Neural Network Working:

Basically used recursive formula



$$S_t = F_w(S_{t-1}, X_t)$$

X_t - Input at time step t

S_t - State at time step t

F_w - Recursive function

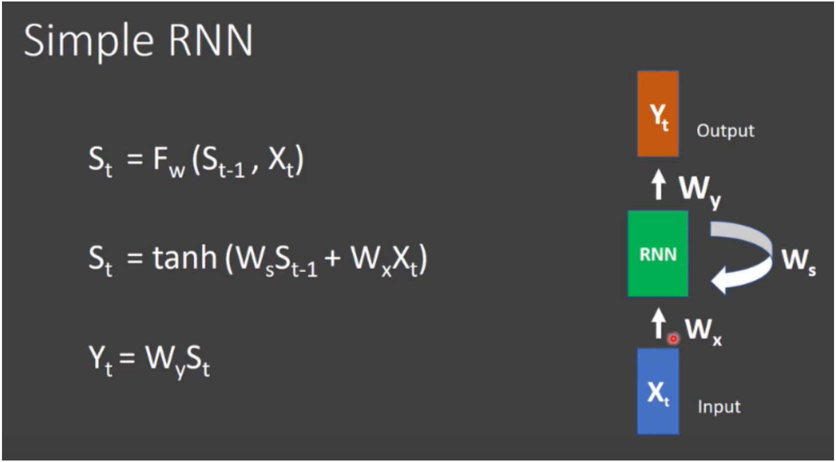
*** xt is the input at time step t.**

*** st is the hidden state at time step t. Its the memory of the network. St is calculated based on the previous hidden state and the input at the current step**

Recursive Function Fw can be replaced by tanh

$$\mathbf{S}_t = F_w(S_t, X_t)$$
$$\mathbf{S}_t = tanh(S_t, X_t)$$

Recurrent Neural Network Working:



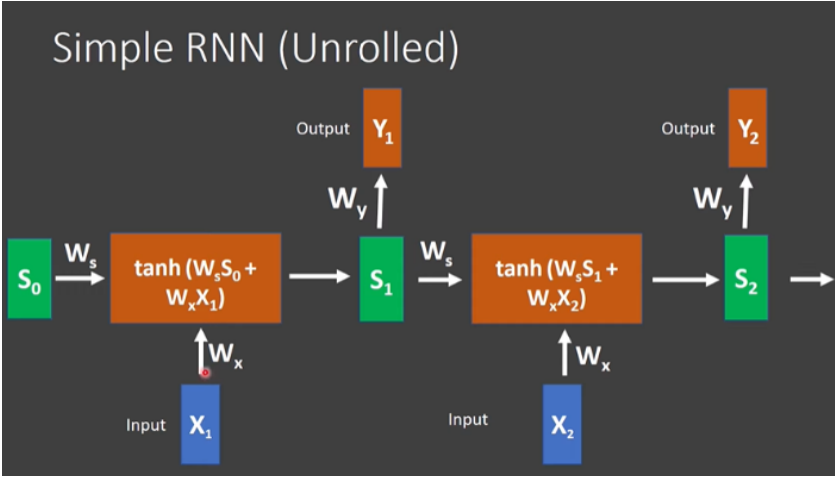
Simple RNN

$$S_t = F_w(S_{t-1}, X_t)$$

$$S_t = \tanh(W_s S_{t-1} + W_x X_t)$$

$$Y_t = W_y S_t$$

Recurrent Neural Network Working:



Problem with RNN

Gradients will vanish over time, and long-range dependencies will only worsen learning.

LSTM

It is a variant of RNN. We have a special gate known as the forget gate, which makes the output from non related nodes non significant while backpropagation making only the significant nides contribute to the gradients. Thus the long range memories exist with out the gradients vanishing..

Loss Function Used

Categorical Cross Entropy

Categorical cross entropy will compare the distribution of the predictions with the true distribution, where the probability of the true class is set to 1 and 0 for the other classes.

$$E = \sum_{i=0}^{C} y_i log(\hat{y_i})$$

Libraries

Libraries Used

Keras And Tensorflow