Seizure Detection Using Time Delay Neural Networks and LSTM

Authors : A. Thyagachandran, M. Kumar, M. Sur, R. Aghoram and H. Murthy

-Presented By
Anand Thyagachandran

Outline

- Introduction
- Proposed Approach
- Network Architecture
- System Comparison
- Summary

Introduction

Neurological disorder in brain

Staring spells, jerking movement, loss of consciousness[1]

Affecting people of all ages

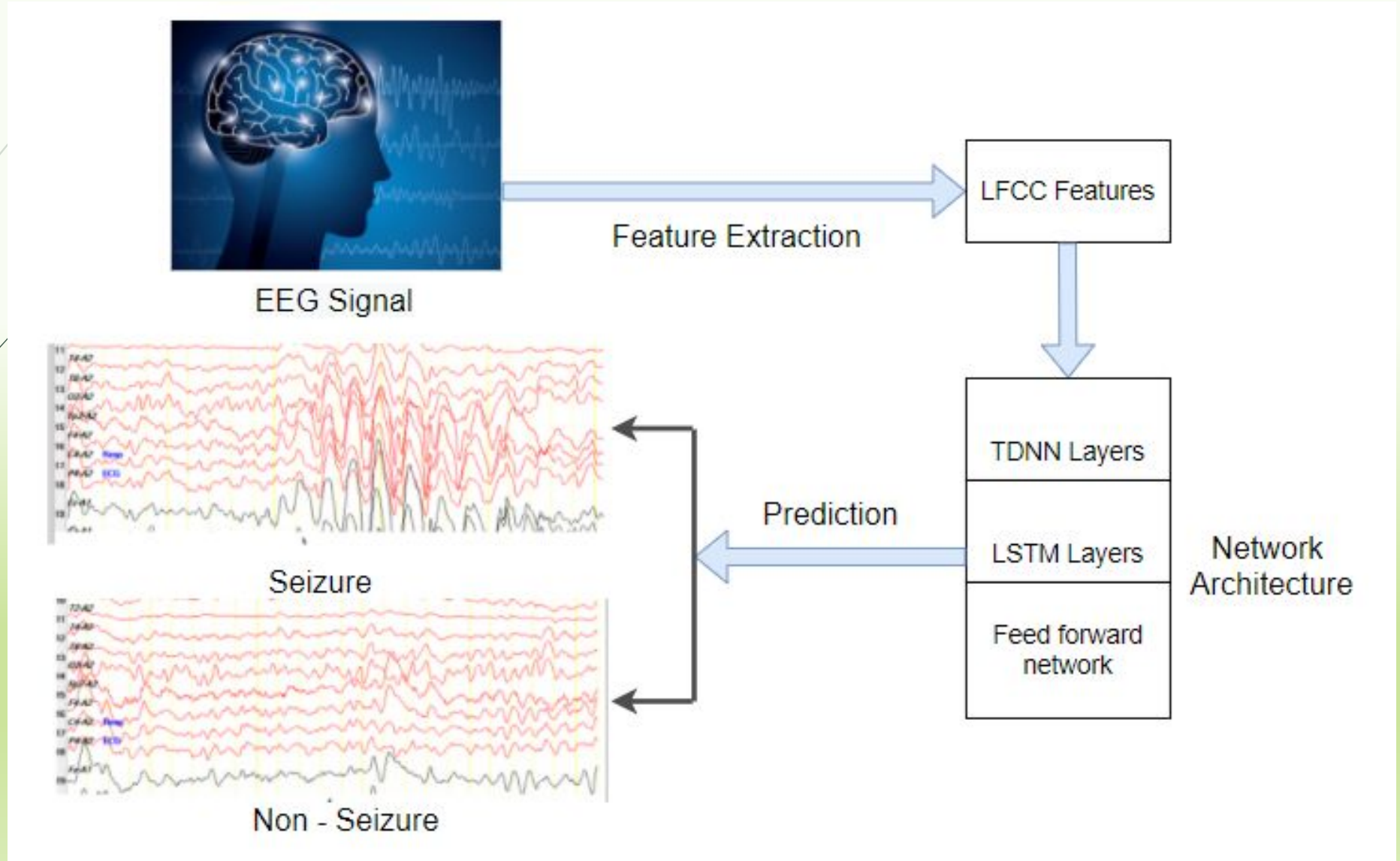
Detection is time-consuming for neurologists[1]

50 million people affected[1]

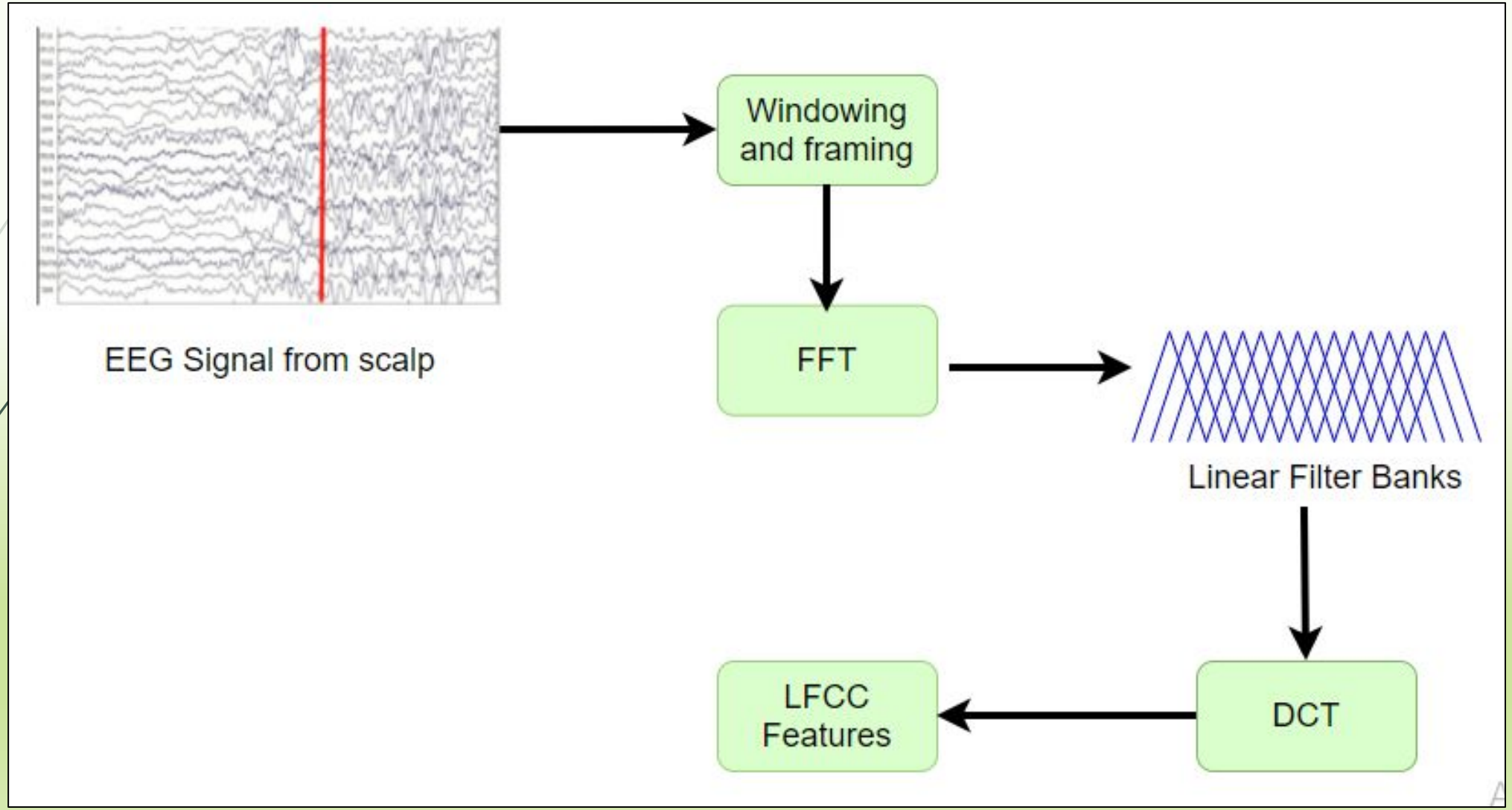
Mortality rate of 1 out of 1000 per year[1]

[1]. Z. Lasefr, S. S. V. Ayyalasomayajula, and K. Elleithy, "Epilepsy seizure detection using eeg signals,"2017 IEEE 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference (UEMCON). IEEE, 2017, pp. 162–167

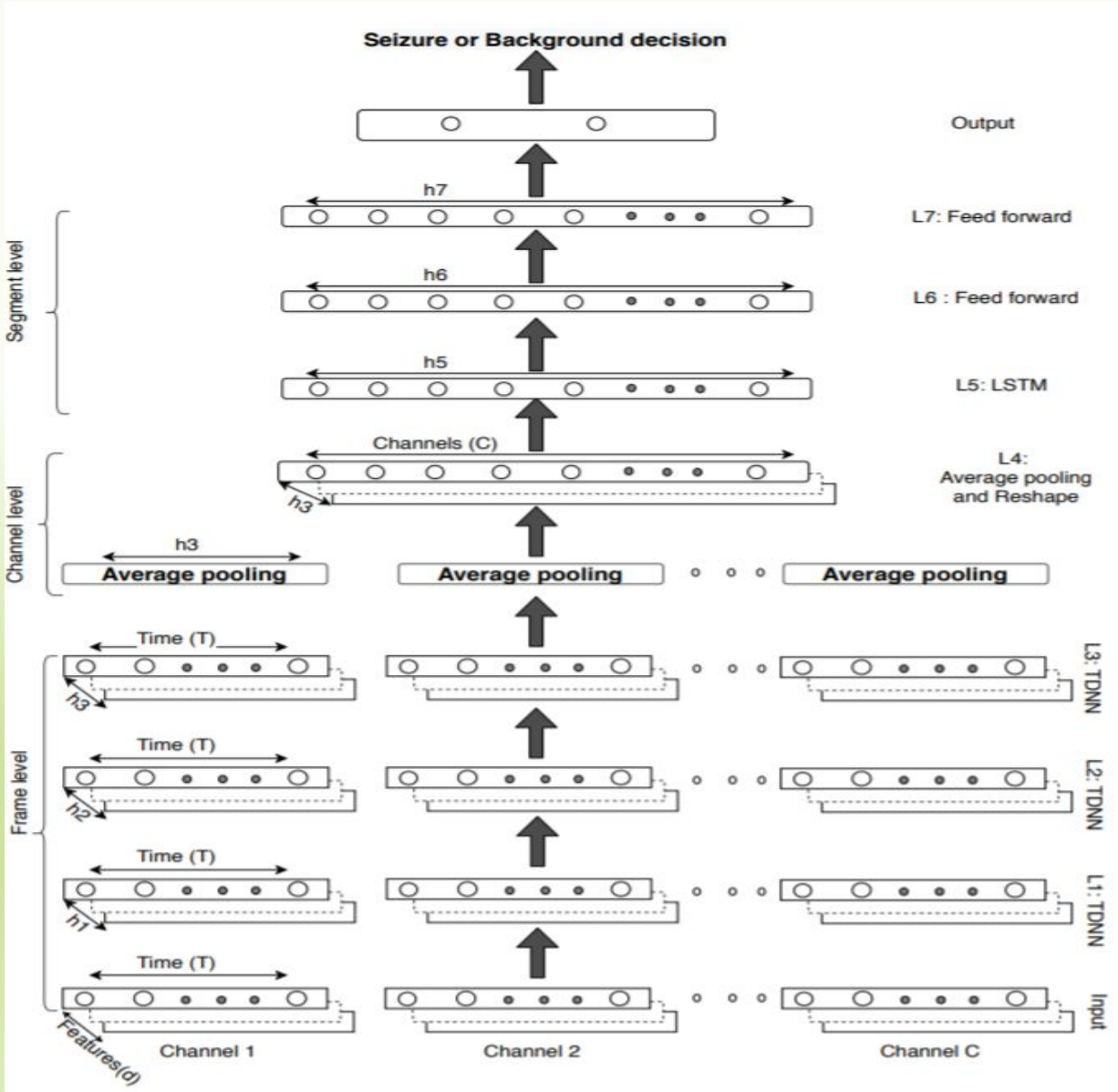
Proposed approach



Features


EEG Signal from scalp
Windowing and framing
FFT
Linear Filter Banks
DCT
LFCC Features

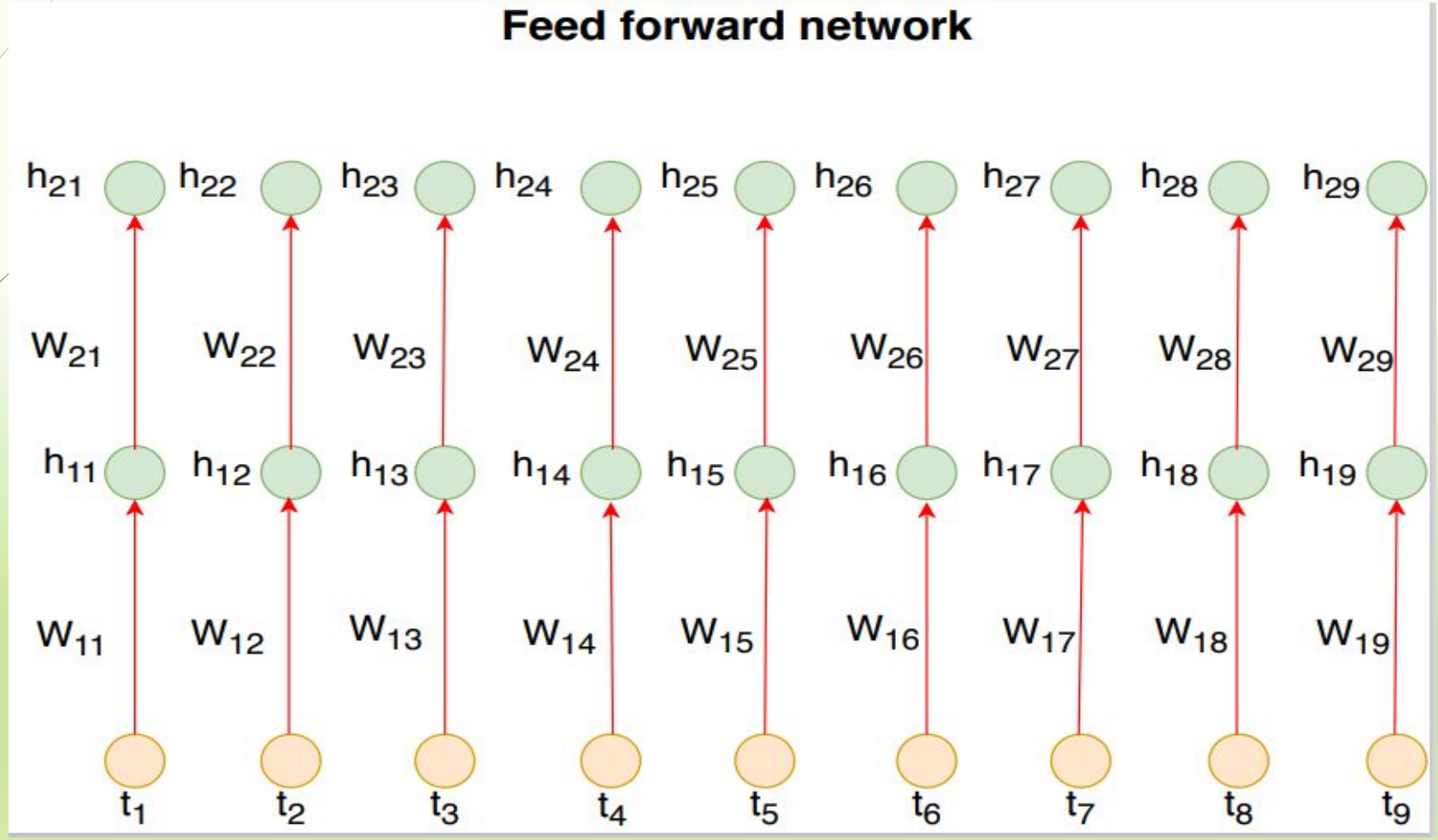
Network Architecture



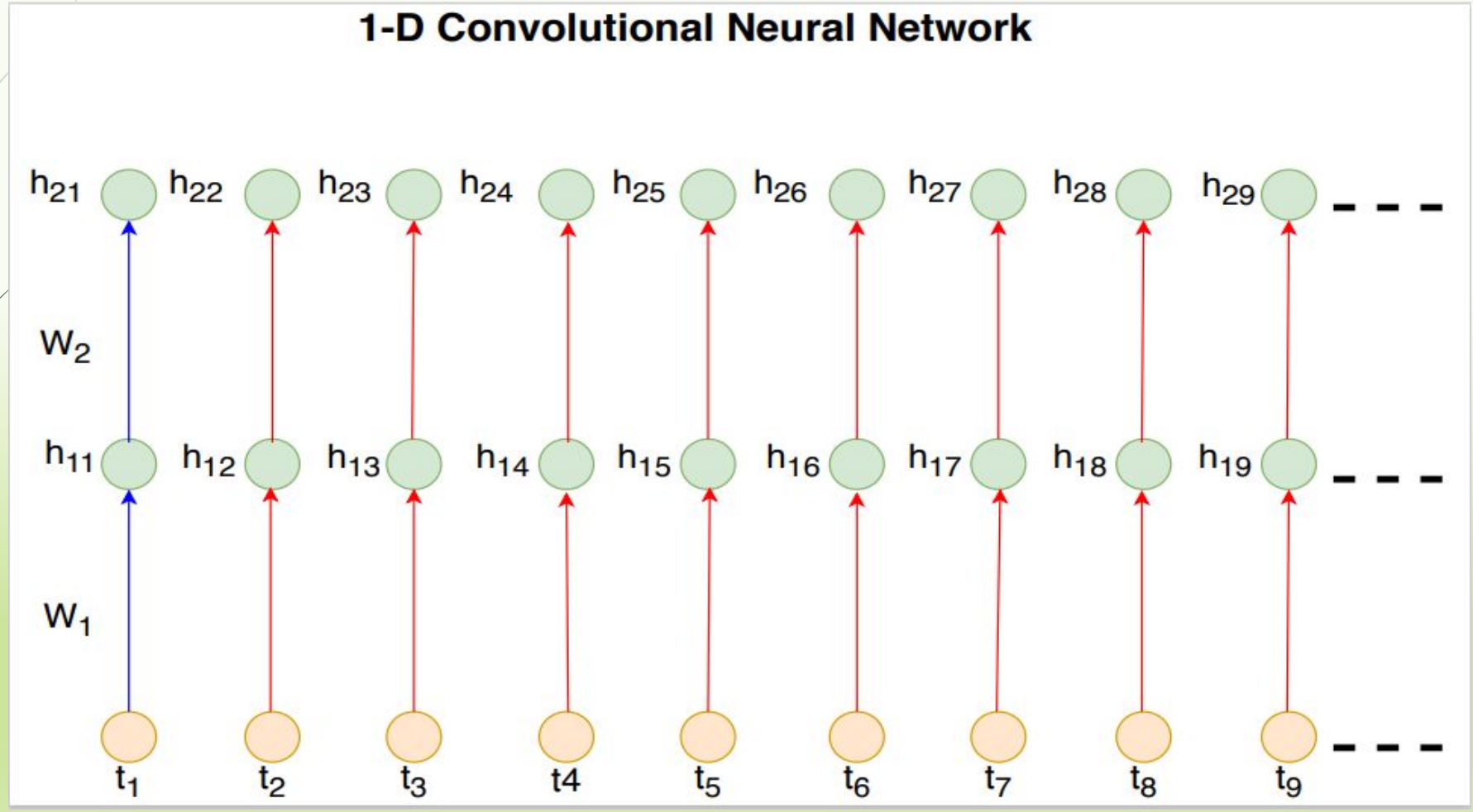
Network Architecture

Layer No	Layer Type	TDNN Filter	Temporal Context	Spatial Context	Input Size	Output Size
1	TDNN	{t-2, t, t+2}	5	0	d X T	256 X T
2	TDNN	{t-4, t-2, t, t-2, t-4}	13	0	256 X T	256 X T
3	TDNN	{t}	13	0	256 X T	256 X T
4	Average Pooling	-	T	0	256 X T	256 X 1
5	LSTM	-	T	C	256 X C	128 X 11
6	FF	-	T	C	128 X 1	32 X 1
7	FF	-	T	C	32 X 1	32 X 1
8	Output	-	T	C	32 X 1	2 X 1

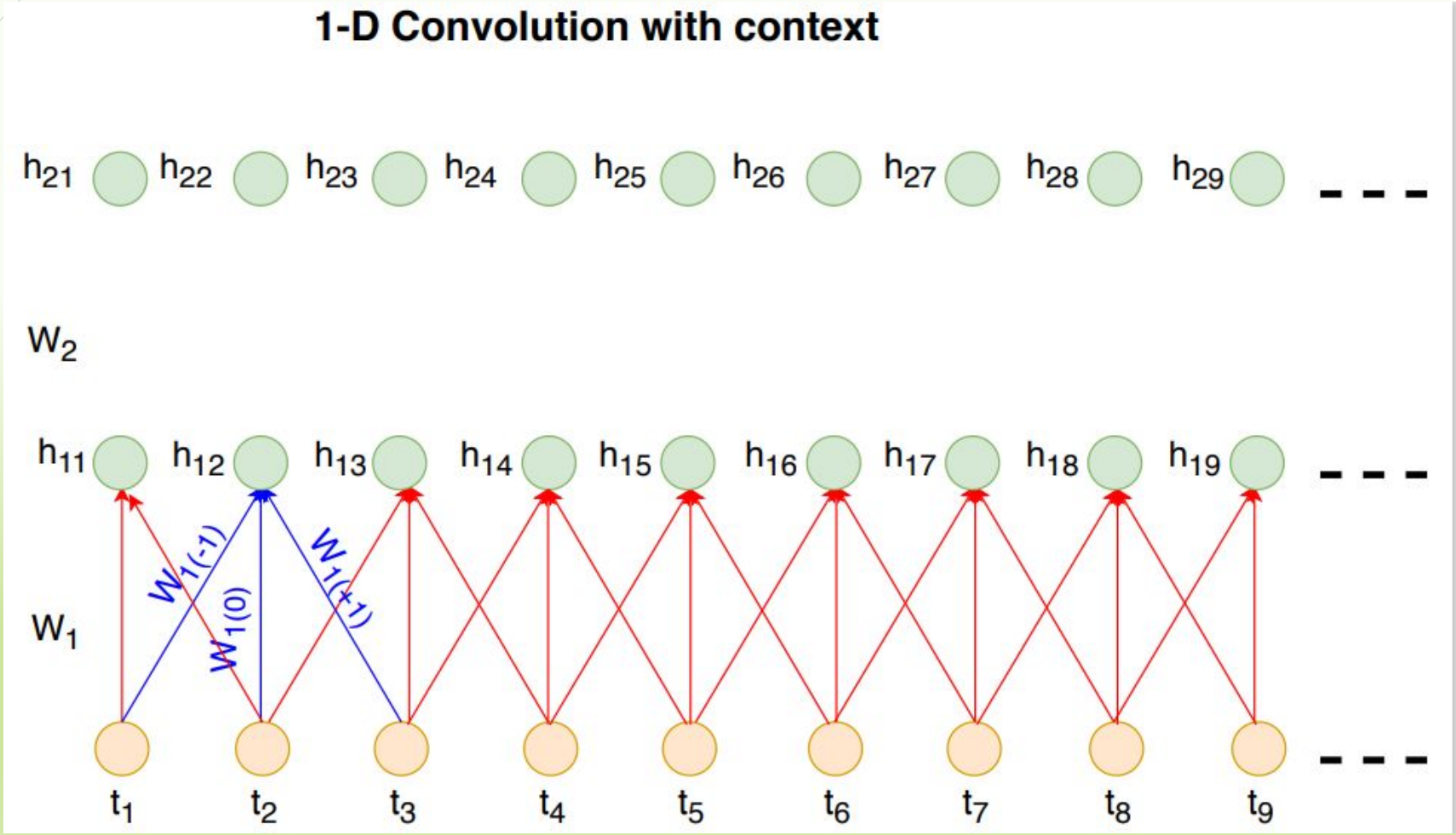
Neural network architecture (Recall)



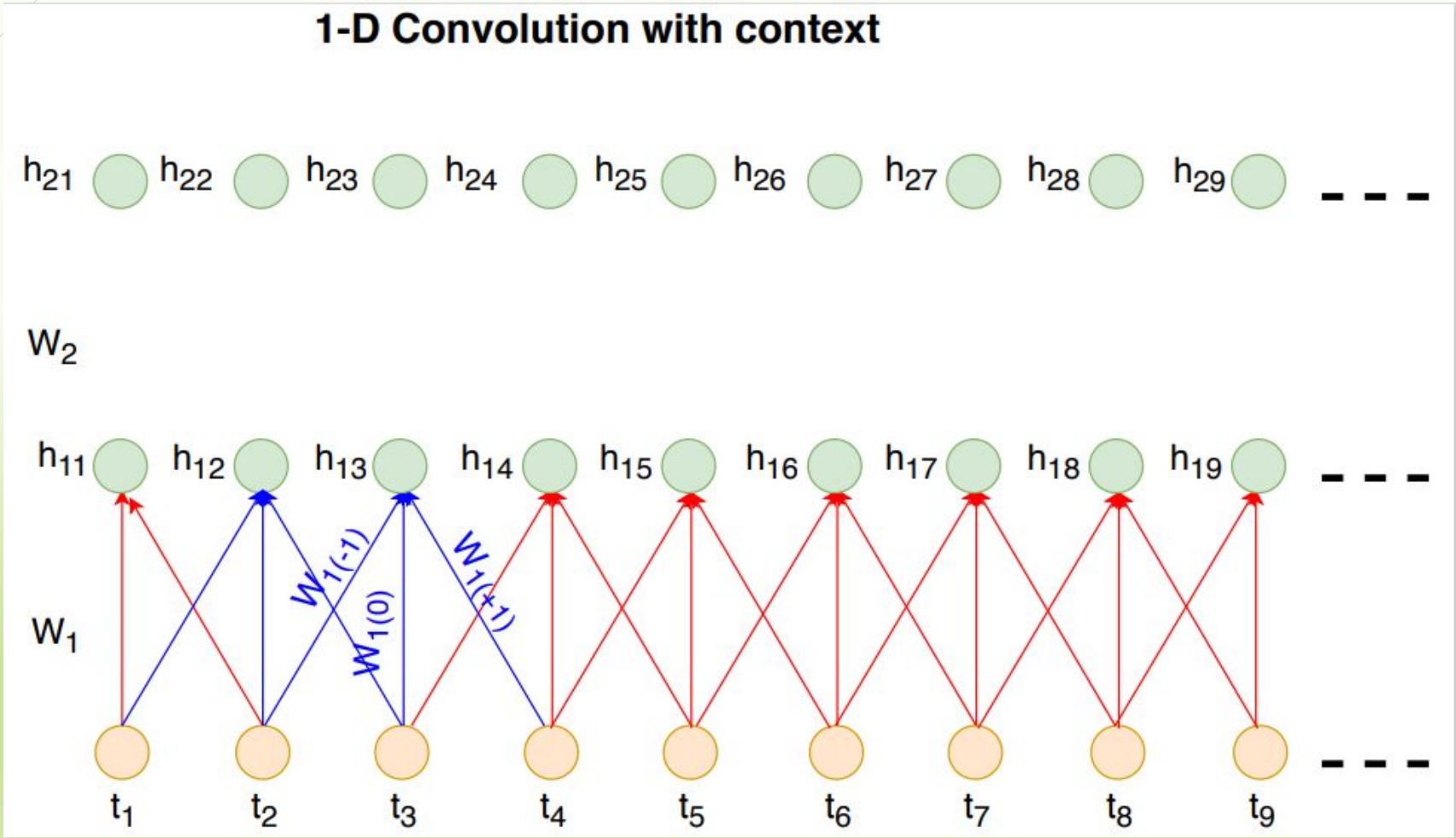
Neural network architecture (Recall)



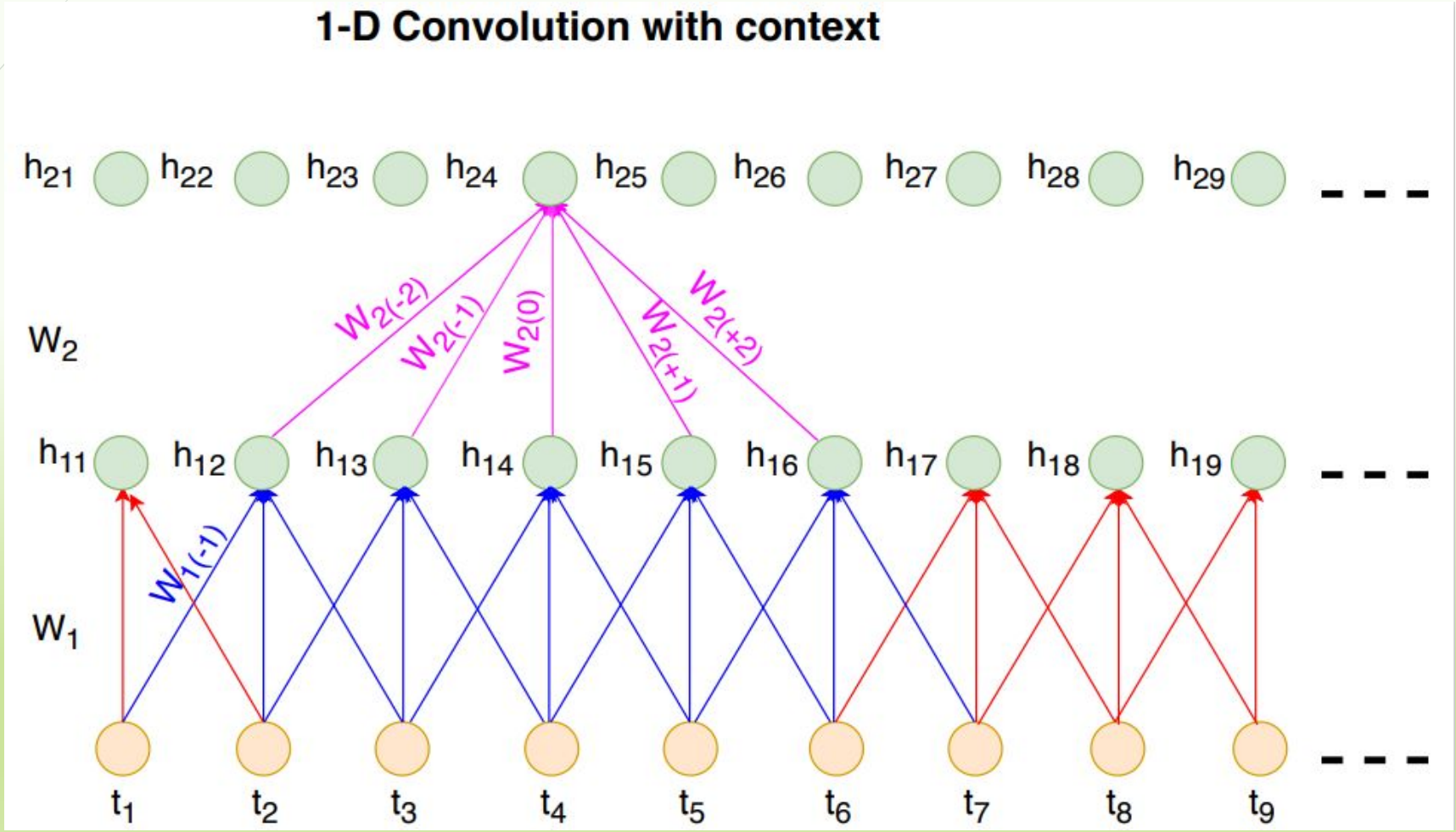
Context dependent CNN



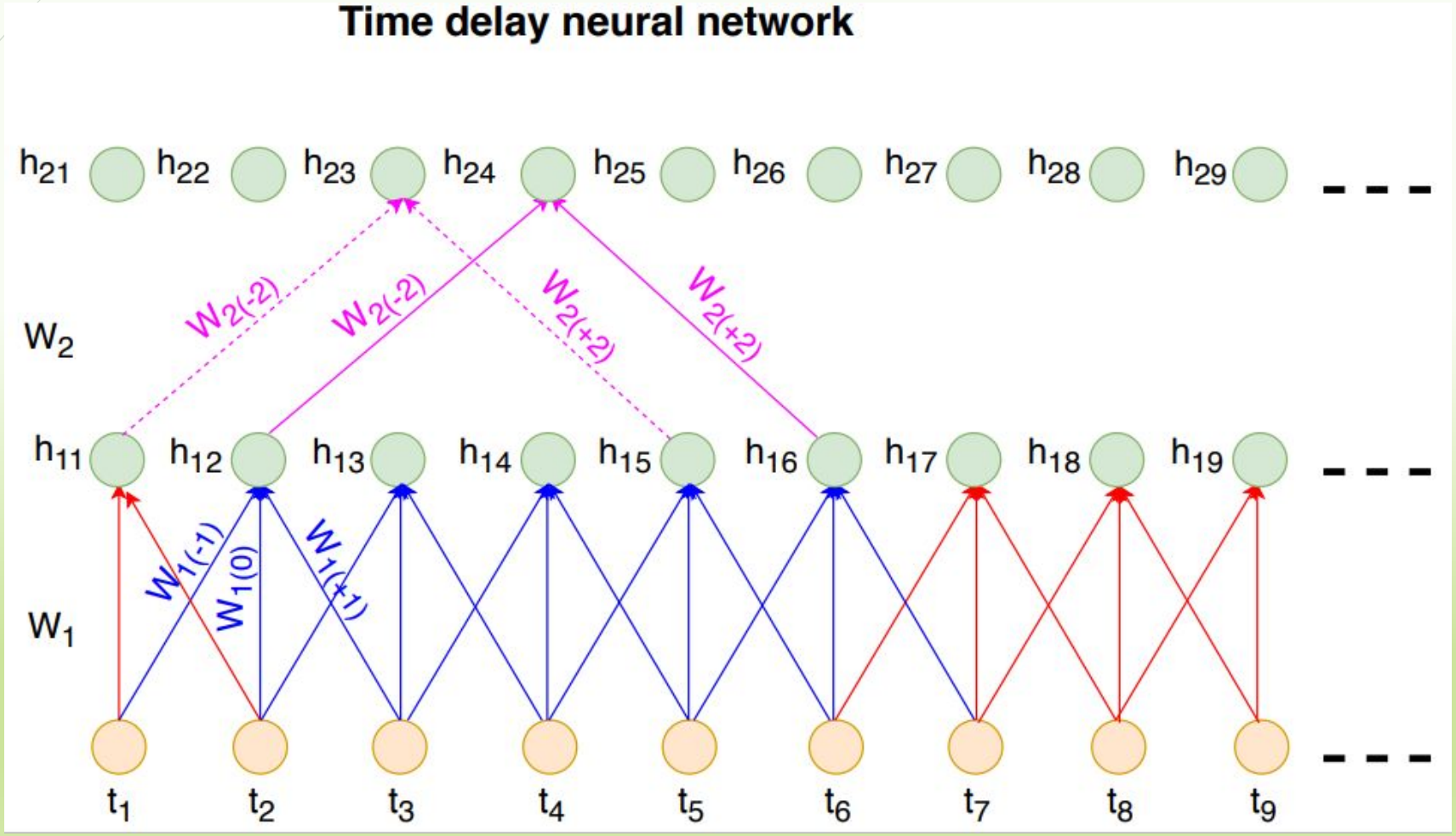
Context dependent CNN



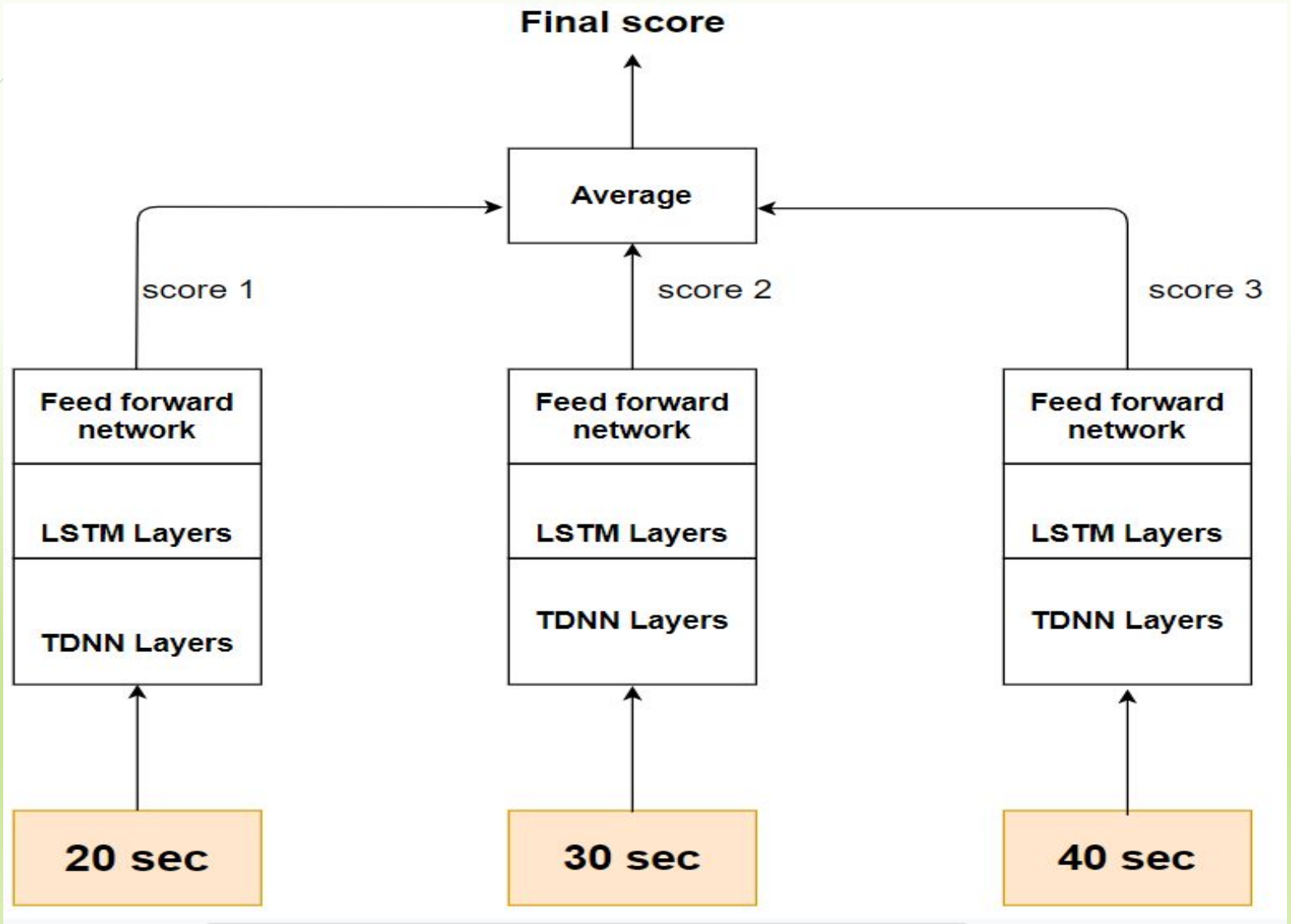
Context dependent CNN



Time delay neural network(TDNN)



Network Architecture



Dataset Description

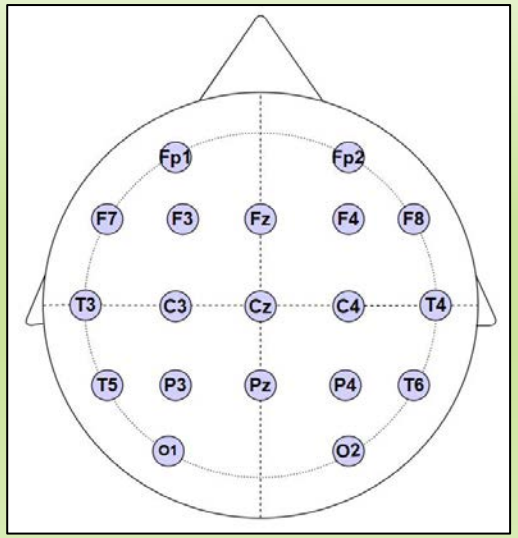
Description	Train	Development
Patients	592	50
Sessions	1185	238
Files	4597	1013
No of Seizure events	2370	673
Seizure (secs)	168,139.23	58,445.11
Non-Seizure (secs)	2,540,144.77	554,786.89
Total (secs)	2,708,284.00	613.232.00

	GS(%)	FS(%)
Training data	**20.59**	**78.56**
Dev data	**35.8**	**57.8**

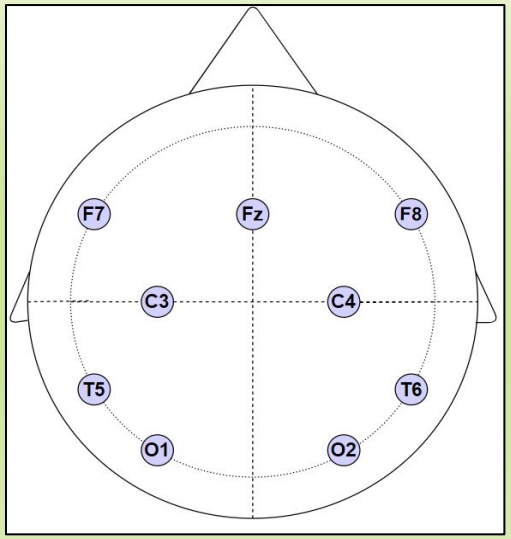
System Comparison

Dev Data	Sensitivity	FA per 24 hours
4-channels	18.87	11.55
9-channels	23.32	11.13
19-channels	21.69	10.56
Evaluation Data	Sensitivity	FA per 24 hours
9-channels	16.00	16.54

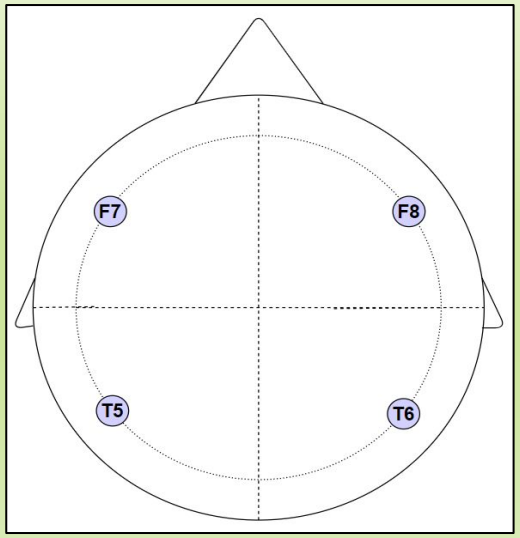
19 channels



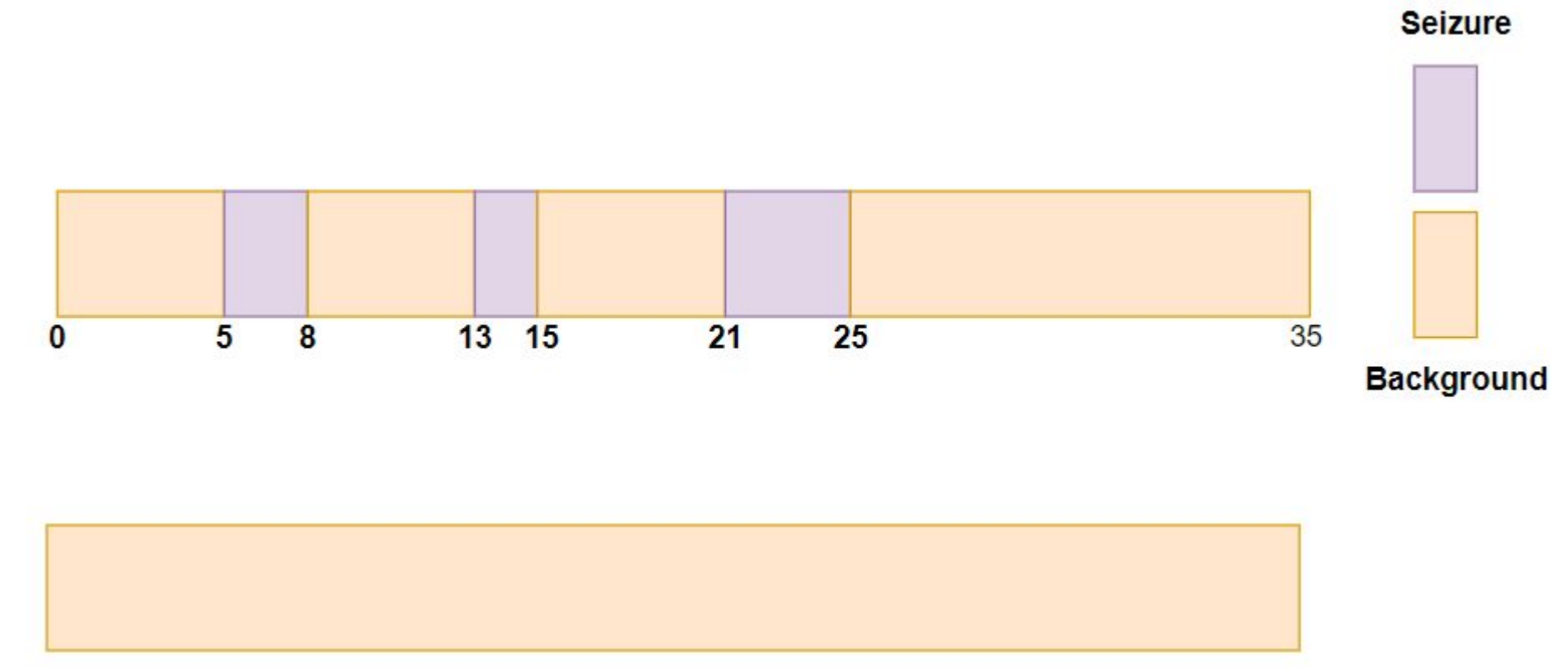
9 channels



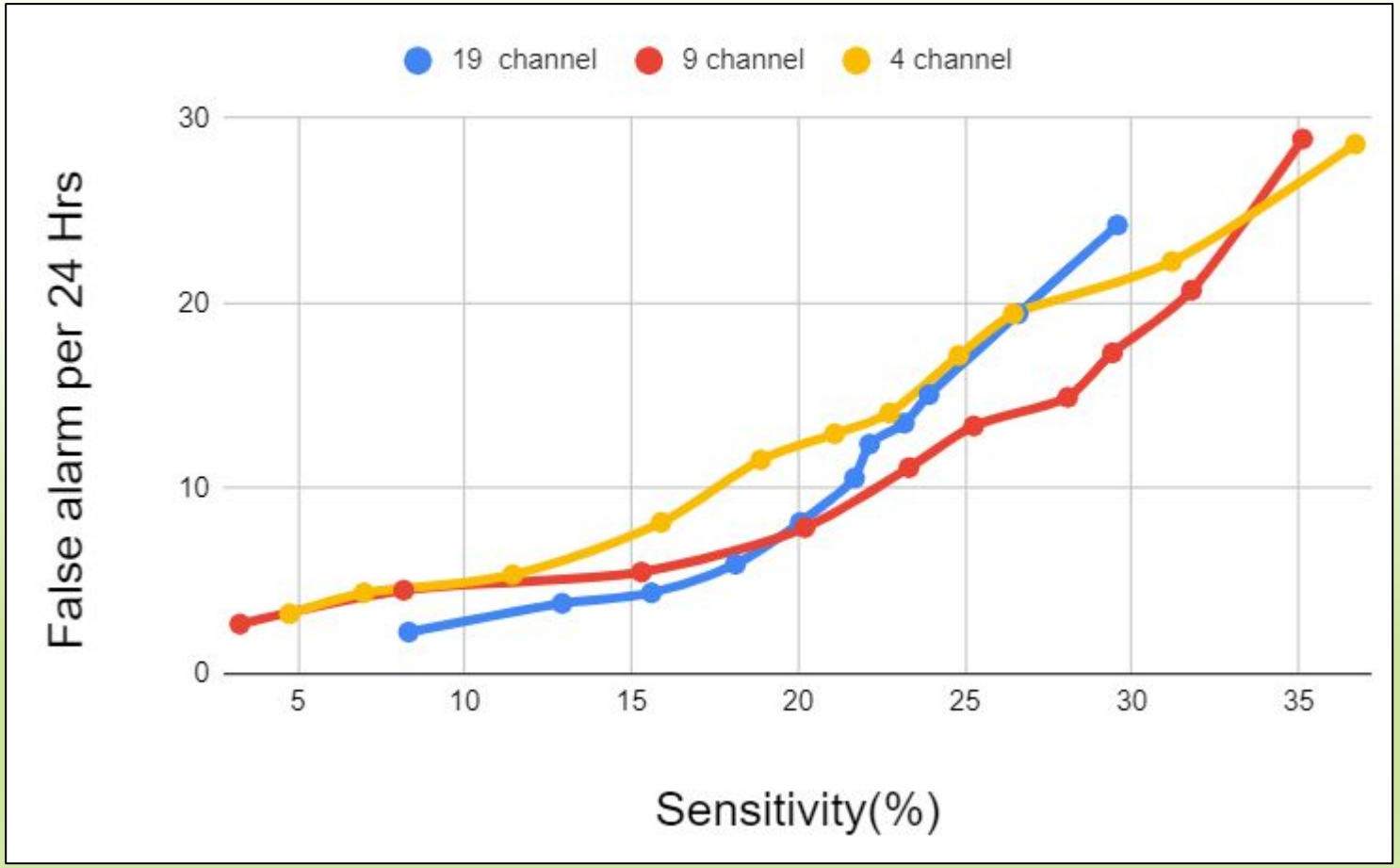
4 channels



Post processing method



Sensitivity vs False Alarm per 24 hours



Summary

- Proposed a novel DNN model using TDNNs and LSTM to detect seizures.
- End-to-end model that takes features from multiple channels and computes the probability of seizure.
- Temporal information modelling: TDNNs, Spatial information modelling: LSTMs.
- Using just 9 channels, the proposed model achieved a sensitivity of 23.32% with 11.13 FAs in 24 hours.
- With 4 channels, the model's sensitivity gracefully dropped to 18% with the same amount of FAs in 24 hours.

Questions ?