Using simulated EEGs to train RNN and analyze real data:

the influence of potassium reversal potential on seizure

Team:

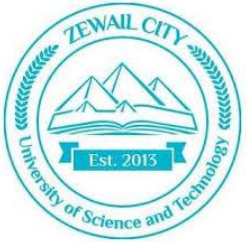
Davi Bezerra

Gabriel Marghoti & João Flauzino

João de Santana

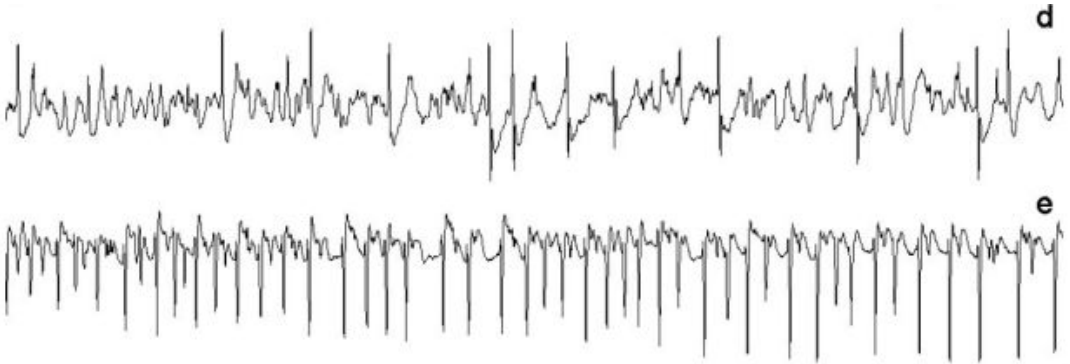
Maria Clara Laport

Ahmed Hamdy



The biological problem

Distinguish EEG seizure signal vs. normal EEG signal



Adapted from Andrzejac et al., 2001

The biological problem

How to simulate that?

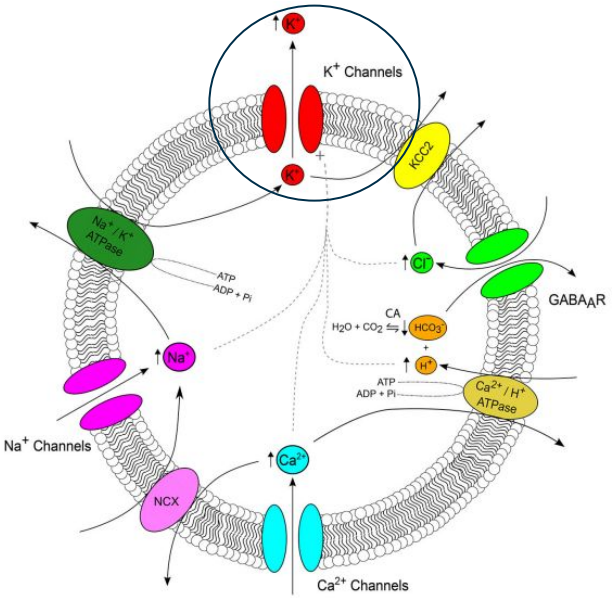
- the role of K+

TABLE 1 | Typical ion concentrations at rest and during an epileptic seizure.

	Typical rest			Typical peak during seizure			
ion	$[ion]_i$	$[ion]_e$	E_{ion}	$[ion]_i$	$[ion]_e$	E_{ion}	**Reference**
K^+	96 mM[1]	4 mM	−85 mV	94 mM	12 mM[2]	−55 mV	Jiang and Haddad (1991) and Dreier and Heinemann (1991)
Na^+	10 mM[3]	145 mM[4]	+71 mV	55 mM[5]	139 mM[4]	+25 mV	Dietzel et al. (1982), Diarra et al. (2001) and Rose and Konnerth (2001)
Ca^{2+}	70 nM	2 mM	+137 mV	700 nM[6]	100 μM[7]	+66 mV	Pumain et al. (1985) and Pal et al. (1999)
Cl^-	7 mM	145 mM	−80 mV	26 mM[8]	152 mM[4]	−47 mV	Raimondo et al. (2013) and Ellender et al. (2014)
pH/HCO_3^-	7.2/15 mM	7.4/24 mM	−13 mV/−13 mV	7.05[9]/10 mM	7.405[10]/25 mM	−25 mV/−25 mV	Caspers and Speckmann (1972) and Raimondo et al. (2012a)

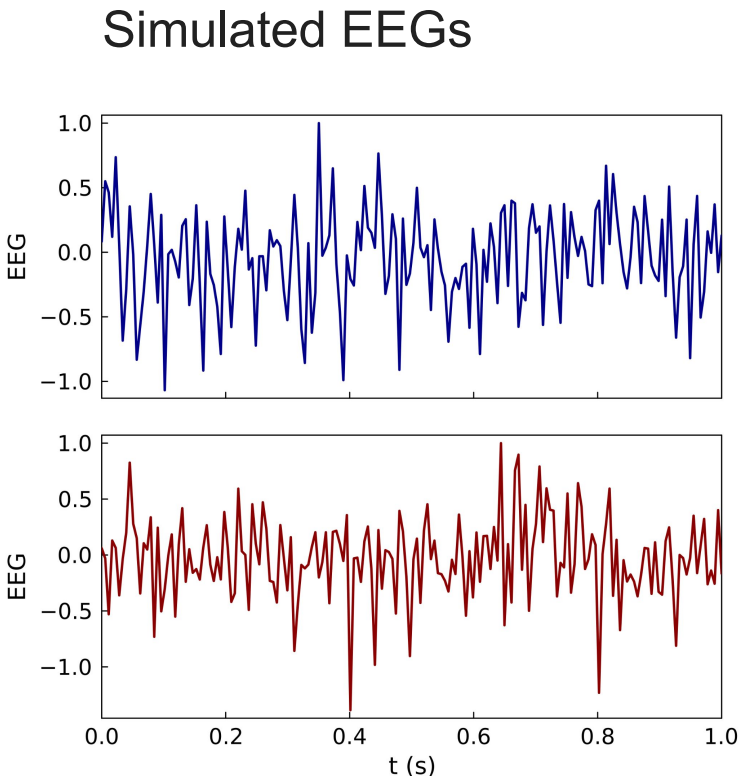
Receptor	Relative Permeability	$E_{receptor}$	$E_{receptor}$
AMPAR	K^+:Na^+/1:1	9.1 mV	0.4 mV
$GABA_AR$	Cl^-:HCO_3^-/4:1	−70.6 mV	−45.8 mV

$[ion]_i$ and $[ion]_e$ indicate the intracellular and extracellular, free ion concentrations, respectively. E_{ion} and $E_{receptor}$ indicate the reversal potentials for ion species and neurotransmitter receptors, respectively. In calculating HCO_3^- concentrations and $E_{HCO_3^-}$ we have assumed that carbon dioxide is equilibrium distributed across the plasma membrane and that the CO_2 hydration reaction inside and outside the cell is under equilibrium. Values in gray have been estimated where data is not available.



Adapted from Raimondo et al., 2015

Simulating our EEG data



Non-seizure

Seizure

Training the RNN

The simulated data was used to train the RNN.

Our Dataset

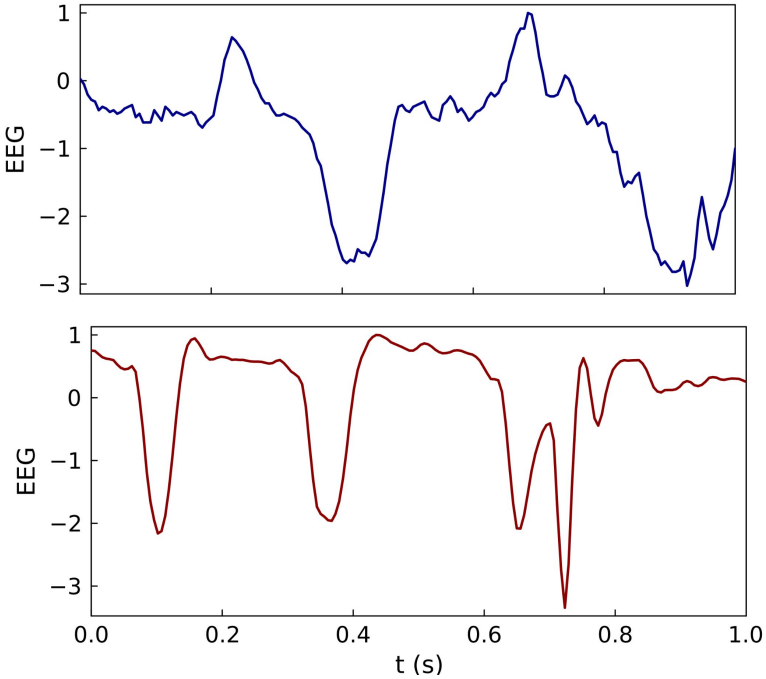
Electrodes implanted in epileptogenic neural zones

*Andrzejak et al. Physical Review E (2001).

Experimental EEGs*

Non-seizure

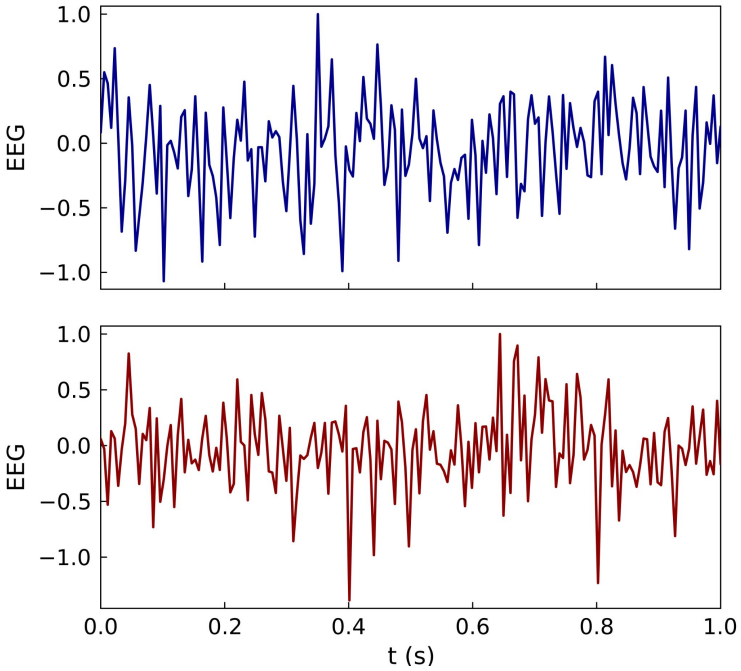
Seizure



Testing the RNN model in real data

Comparison between the normalized signals

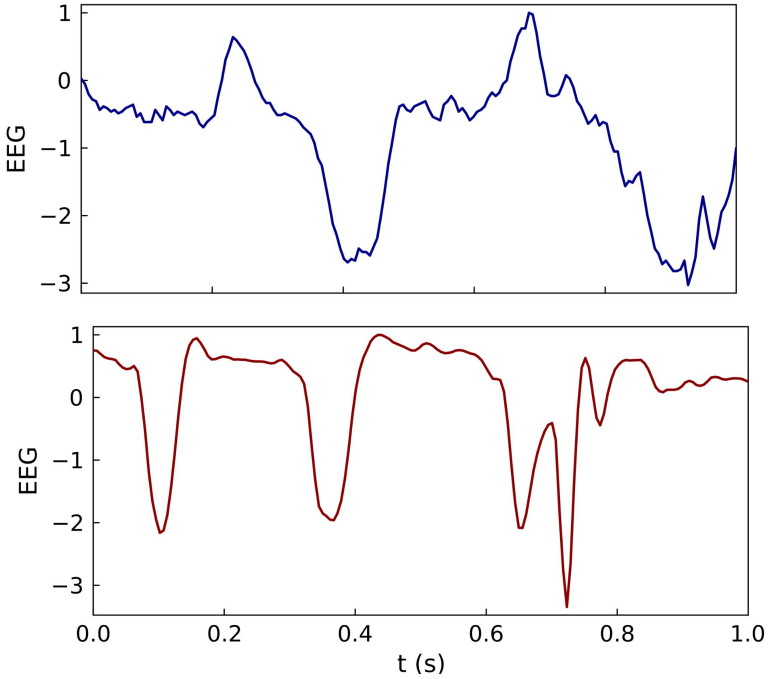
Simulated EEGs



Non-seizure

Seizure

Experimental EEGs*



*Andrzejak et al. Physical Review E (2001).

Thank you all!

Obrigado!

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