Enhance Feature Representation of Electroencephalogram for Seizure Detection

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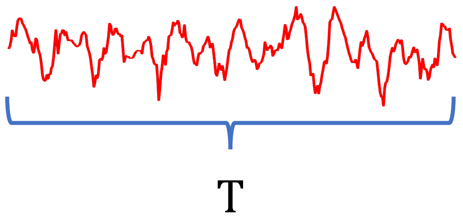
Background

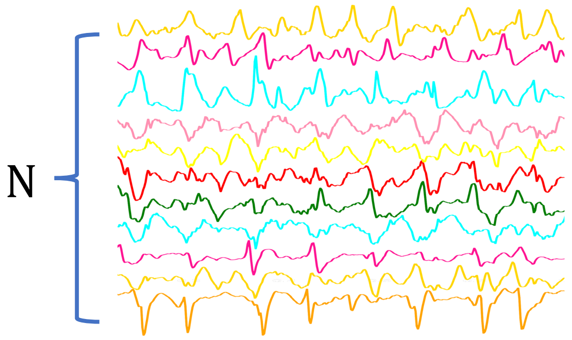
- Epilepsy affects over 65 million individuals, nearly 1% of the global population
- Seizure detection is necessary for those patients who cannot be cured through surgery and medicine
- EEG data is a kind of important signal.

How to enhance feature representation of EEG for seizure detection?

Challenges & Solutions



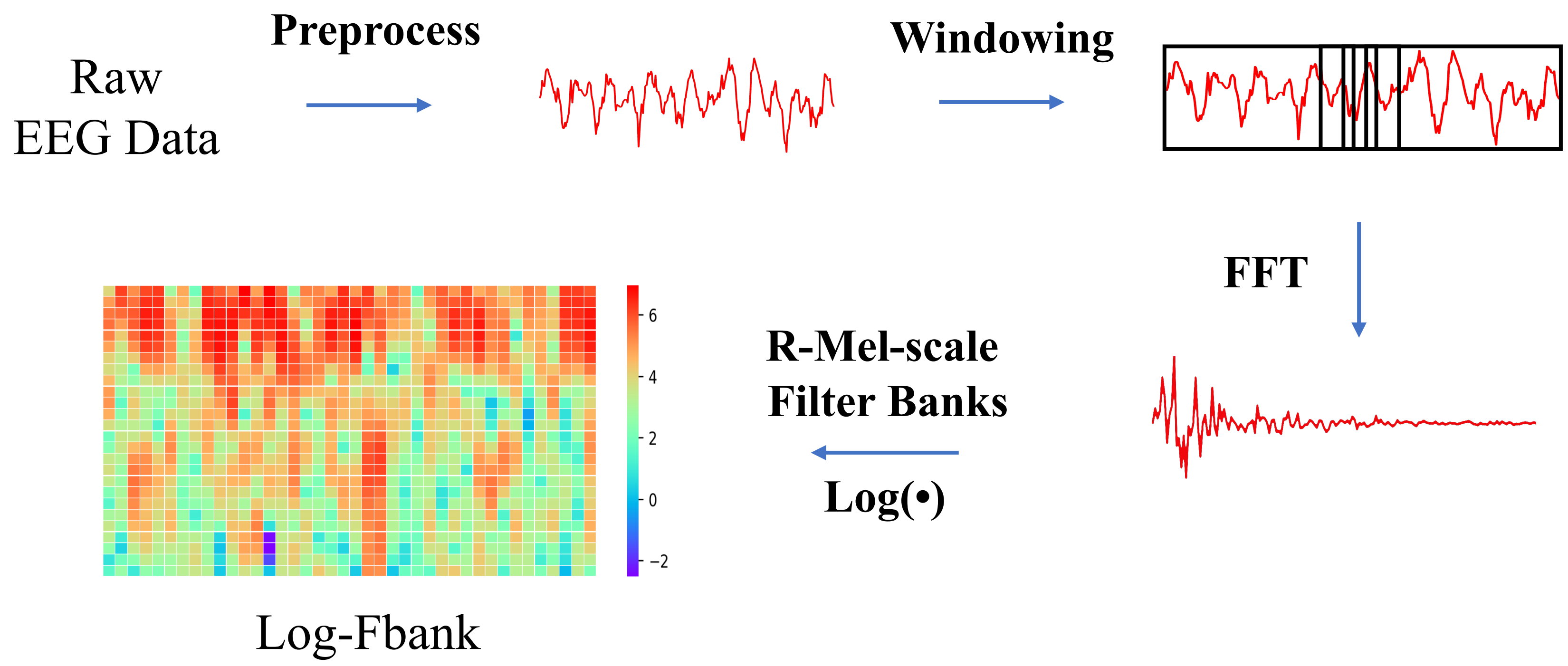
Data Redundancy → Log Mel-filter bank energy (LogFbank)



Multi-Channel → Sequential Forward Channel Selection (SFCS)

Log Mel-filter bank energy

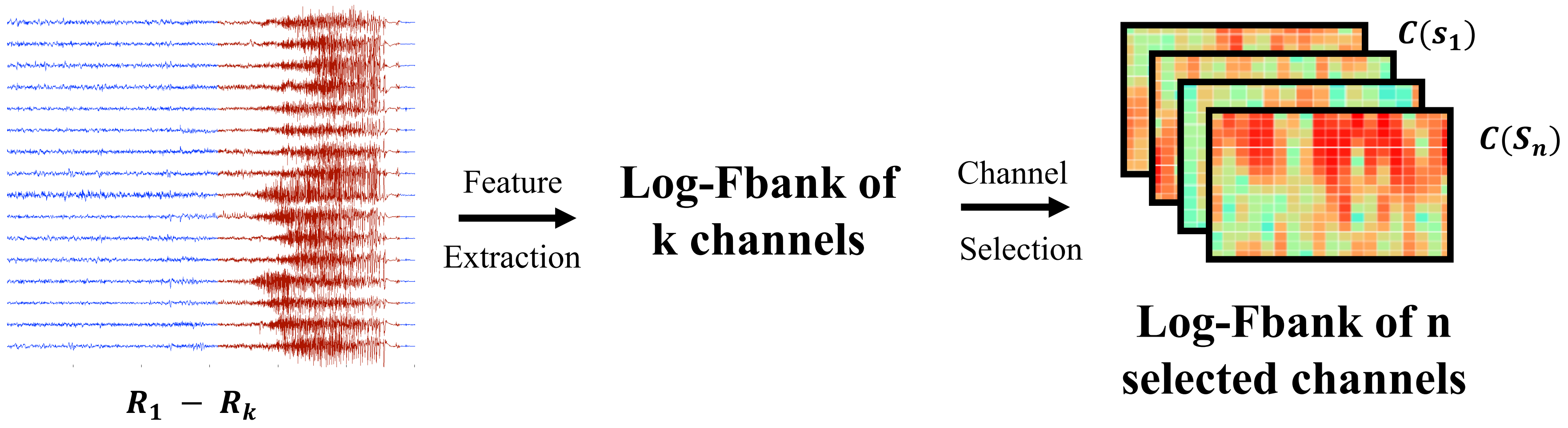
- MFCC
- Frequency analysis
- More discriminative
- Robust



Sequential Forward Channel Selection

Criterion function as J

a. Initialize $C = \{c_1, c_2, \cdots, C_k\}, S = \emptyset$
b. For all the channels in remainder subset $c_t \in (C - S)$, compute $J(c_t)$
c. Choose the maximum value of $J(c_t)$, denote as $J(c_{t_m})$. And computer $J(S \cup c_{t_m})$. If the result of $J(S \cup c_{t_m})$ is the best, recording the corresponding channel c_{t_m}, set $S = S \cup c_{t_m}$. If $(C - S) = \emptyset$, stop, otherwise turn to Step b.
d. Output the target channel set.



Experiments

Table 2. Summary of results. Channel Set 1 is selected by SFCS and Channel Set 2 is top 3 channels by SFCS.

	proposed method					Truong et al. [10]			Hills [11]
Subject	Full Channel	Channel Set 1		Channel Set 2		Full Channel	Channel Set		Full Channel
Dog1	98.67	(10)	98.78	(10)	98.78	98.44	(4, 10, 12)	98.78	**99.63**
Dog2	99.56	(6,7,8,12)	**100.00**	(8,12)	99.77	96.30	(1, 9, 12)	98.92	96.86
Dog3	98.16	(1,2,3,4,6,7,8,10,11,13,14)	98.18	(3,7,8)	96.02	**98.88**	(7, 13, 14)	95.45	98.47
Dog4	**100.00**	(1,7,12,16)	**100.00**	(7,12,16)	99.74	94.26	(7, 8, 15)	99.05	99.61
Patient1	98.54	(19, 56)	**100.00**	(19,56)	**100.00**	93.49	(19, 27, 30)	97.50	99.32
Patient2	94.95	(1, 6, 8, 9, 14)	95.96	(1,6,8)	95.23	98.72	(1, 2, 3)	94.60	**99.73**
Patient3	99.92	(5,6,13,45,55)	**99.94**	(6,45,55)	99.64	94.68	(5, 6, 26)	98.29	95.01
Patient4	**100.00**	(2)	**100.00**	(2)	**100.00**	**100.00**	(37, 45, 66)	**100.00**	67.50
Patient5	96.94	(1,2,15,17)	**99.43**	(1,2,17)	98.42	83.83	(9, 18, 25)	93.05	96.75
Patient6	98.64	(16,17,24)	**99.82**	(16,17,24)	**99.82**	99.61	(15, 23, 24)	99.27	99.86
Patient7	98.91	(26,27,28,30,31,32,33)	99.23	(27,30,31)	98.14	94.24	(26, 28, 36)	99.06	**99.99**
Patient8	96.37	(11,13)	**98.25**	(11,13)	**98.25**	97.71	(3, 10, 11)	96.52	98.15
Average	98.39		**99.13**		98.65	95.85		97.54	95.91

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Conclusions

- Propose the frequency domain feature LogFbank
- Propose SFCS for automatic channel selection

Thanks !