

# Enhancing Arousal and Sleep Scoring in In-home EEG Signals using Multitask Learning

Juan Carlos Neira Almanza, Leo Ota, Kazumasa Horie, Fusae Kawana, Toshio Kokubo, Masashi Yanagisawa, Hiroyuki Kitagawa.

Arousability, a key indicator of sleep disruption, is notoriously challenging to score. By utilizing an advanced AI technique known as multitask learning, we enhanced the accuracy of scoring arousability in in-home portable EEG recordings.

## Introduction

- Previous research highlights a correlation between arousability and insufficient sleep.
- Portable in-home EEG devices, like InSomnograf by S'UIMIN, have been developed to enhance sleep monitoring.
- While AI models have achieved promising results in sleep scoring, arousal scoring remains less effective.



Fig.1 Lack of Sleep



Fig.2 InSomnograf

**Multitask learning, which trains a model for both sleep and arousal simultaneously, has been proposed as a more effective approach.**

## Methodology

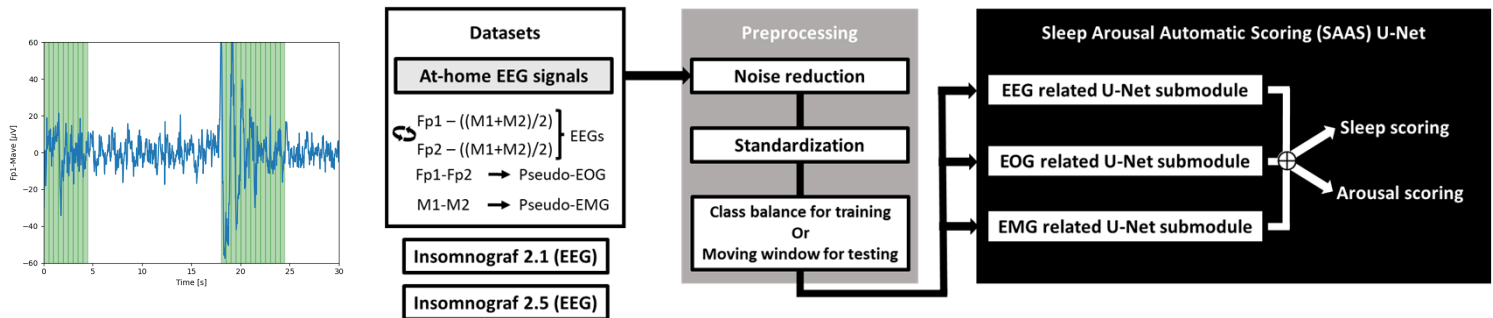


Fig.3 Analysis process of In-home EEG data with SAAS

- We analyzed two InSomnograf datasets: InSomnograf 2.1 and 2.5. Each one composed of four channels.
- Before the analysis, we preprocessed the signals, reducing the noise and balancing sleep stages with regards to arousal / not arousal epochs.
- Our model, named SAAS U-Net, allows us to obtain arousal and sleep scoring results.

## Results & Discussion

InSomnograf phase 2.1 dataset arousal results (%)								
Method	Prec.	Sens.	Acc.	Spec.	F1	K	AUROC	AUPRC
Single	76.4	57.0	91.1	97.0	65.3	60.3	<b>89.5</b>	72.8
Multi.	<b>81.2</b>	<b>61.3</b>	<b>92.2</b>	<b>97.6</b>	<b>69.8</b>	<b>65.5</b>	85.8	<b>72.9</b>
InSomnograf phase 2.5 dataset arousal results (%)								
Method	Prec.	Sens.	Acc.	Spec.	F1	K	AUROC	AUPRC
Single	73.2	64.8	91.7	96.1	68.8	64.0	<b>90.5</b>	<b>73.7</b>
Multi.	<b>73.5</b>	<b>66.4</b>	<b>91.9</b>	96.1	<b>69.8</b>	<b>65.2</b>	89.3	72.8

InSomnograf phase 2.1 dataset sleep results (%)						
Method	Prec.	Sens.	Acc.	Spec.	F1	K
Single	<b>75.1</b>	<b>75.5</b>	<b>80.7</b>	<b>94.8</b>	<b>75.0</b>	<b>73.3</b>
Multi.	73.9	74.9	79.5	94.5	74.1	71.7
InSomnograf phase 2.5 dataset sleep results (%)						
Method	Prec.	Sens.	Acc.	Spec.	F1	K
Single	72.9	<b>74.5</b>	<b>77.9</b>	<b>94.0</b>	<b>73.6</b>	<b>69.3</b>
Multi.	<b>73.1</b>	72.1	77.7	93.7	72.5	68.4

- Our results show that multitask learning improves arousal scoring in portable in-home EEG but does not enhance sleep scoring.
- This may be due to the contextual information from sleep stages that aids arousal scoring, while the reverse effect is limited.
- We encourage further research on multitask learning for sleep evaluation and related conditions.