Abstract

Dementia is a disease that interferes with daily life due to the deterioration of memory and thinking ability. As the world's population ages, the impact of dementia on society is expected to increase. Although there are many diseases that cause dementia, there is still no fundamental cure for most of them, and the only effective treatment is symptomatic relief in the early stages of the disease. Therefore, it is important to detect dementia in its early stages, and research on automatic dementia detection systems that utilize various types of data is ongoing.

It is known clinically and physiologically that dementia affects sleep in various ways. In this study, we collected activity data during sleep using mattress-type sensors installed in four welfare facilities for the elderly in Japan with the aim of constructing a system to automatically estimate dementia from data collected during sleep. In addition, the Mini Mental State Examination (MMSE), a screening test for dementia, was administered to some of the participants, and their cognitive status was estimated according to the results.

To confirm the statistical nature of the obtained sleep data set, we statistically confirmed that there was a predominant difference between the high and low scoring groups on the dementia scale score for a portion of the activity measured during their sleep.

Next, using data collected from 144 participants, we compared several bicategory prediction systems for dementia scale scores based on LSTM, Support Vector Machine, and Random Forest, using only the amount of activity during sleep. All systems achieved an accuracy of over 0.62 on the Macro F1 score, indicating that it is possible to estimate the cognitive state scale to some extent even from sleep data alone. The LSTM model achieved the highest accuracy of 0.67 on the Macro F1 score. Next, by applying SHAP to the model using Random Forest, we confirmed that the feature with the largest contribution to the estimation was the depth of sleep.

Next, feature extraction methods based on X-Means, Auto Encoder, and PCA were compared. We confirmed that all feature extraction methods improved in accuracy, and the feature extraction method using X-Means achieved the highest accuracy of 0.79 on the Macro F1 score. Finally, we constructed a discrimination system using an abnormality detection model to separate sleep data into typical healthy sleep and typical unhealthy sleep. The highest Macro F1 score of 0.91 was achieved in the subsequent discrimination experiments.

The mattress-type sensor used for data collection is a commercially available product and is inexpensive compared to specialized medical equipment. It is difficult for people to recognize the signs of dementia by themselves, and it is not always possible for all people to have a third party who can recognize the trend of

cognitive decline. This study is part of a clinical study on the relationship between dementia and sleep, and suggests that sleep information can be used as part of an automatic dementia detection system that has been studied using various modalities. The study is part of a clinical study of the association between dementia and sleep.