Discussing Applications of Machine Learning for Sleep Pattern Dynamics

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Abstract

Sleep, an essential physiological process, plays a pivotal role in maintaining overall human health and well-being. It serves as a fundamental period during which the brain undergoes essential restorative processes, while the body rejuvenates itself. Regrettably, a considerable portion of the global population encounters disruptions in their sleep patterns, leading to a range of challenges in their awake hours. The scientific community, recognizing the significance of sound sleep, has embarked on extensive investigations to unravel the intricacies of sleep cycles and to develop methodologies for more accurate analysis of recorded sleep data. Over the course of history, diligent efforts by scientists and researchers have led to the development of sophisticated tools and techniques for comprehending the dynamics of sleep. A notable area of advancement in recent years has been the fusion of machine learning with sleep analysis. Among the various machine learning algorithms, certain approaches have demonstrated exceptional efficacy (90 percent or above) in accurately delineating the distinct stages of sleep. These stages, characterized by varying levels of brain activity, eye movement, and muscle tone, are integral for comprehending sleep patterns and diagnosing sleep disorders.

1. Introduction

During recent years, many researchers have studied patients' sleep in order to further improve accuracy of sleep scoring. Sleep science is the study of the brain and bodily functions during sleep in order to assess a patient's likelihood of sleep disorder. During sleep, one undergoes different stages that entail various unique physical changes. There are 5 main sleep stages: Wakefulness, Rapid Eye Movement (REM), NI, N2, and N3. Wakefulness is characterized as a conscious state where an individual's eyes are open and they are performing actions. During the Rapid Eye Movement sleep stage, an individual's muscles are paralyzed, their heart rate is increased, and their eyes move rapidly. The most notable feature of REM sleep is that there are small variable-speed brain waves[1]. The N1 Stage is considered to be a light sleeping stage that occurs almost immediately after an individual falls asleep. However, the N2 Stage can be more accurately classified as it produces slow-wave brain activity[2]. The body also experiences a drop in temperature during N2 Sleep, and in addition to the shift in brain wave pattern, eye movement notably stops[3]. The N3 Stage of sleep is the deepest stage; some involuntary movements may occur during this stage, and it is very hard to be awakened. The body is fully relaxed during this stage so its main traits are decreased pulse and breathing rates. The brain waves are more clearly identifiable Delta Waves. The reading of these brain-waves and other alterations in bodily functions is called sleep scoring.

Sleep researchers have studied methods in which sleep stage identification can be more accurate. The main purpose of sleep studies is to identify irregularities in sleep patterns in patients for diagnosis of sleep disorders. Sleep disorders can be classified as anything that inhibits the time, quality, or amount of sleep a patient receives such that their day time activities are compromised. As an effect of carrying a sleep disorder, several patients undergo damage to both their physical and mental health. In addition to their inability to perform day time tasks to their fullest capacity, most patients experience depression, anxiety, or cognitive disorders[4]. As of May 2023, 50-70 million people in just the United States face a sleep disorder. Any advancement in the accuracy of sleep stage recognition could lead to an improvement in the diagnosis and treatment of these people[5].

Starting from the opening of the first sleep lab in the 1920s by Dr. Nathaniel Kleitman[6], many scientists and researchers have analyzed the accuracy of sleep scoring methods and have attempted to improve them causing a substantial improvement to the identification of sleep disorders. However, the average accuracy of current methods still remains near 80 percent[7]. This paper will be highlighting the evolution and progress of various achievements in sleep scoring, and will create a pathway to further improve this aspect of the medical field.

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