1 **REM SLEEP STAGE IDENTIFICATION WITH WAVELET DECOMPOSITION AND ARTIFICIAL NEURAL NETWORK USING A SINGLE CHANNEL EEG**

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2 **Why Use Sleep Stages?**

- Separate Wakefulness from Sleep state
- Identify physiologic and pathologic events
  - Paralysis in REM
  - Arousals and pathology (Apnea)
  - K-complexes and pathology (Epilepsy)
- Required for some sleep studies with EEG
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3 **What is an EEG?**

- Electroencephalogram
- Difference in electric potentials
- Produces "brain waves"

4 **How to Identify Sleep Stages?**

- American Academy of Sleep Medicine
- Polysomnography or Polysomnographic Record (PSG)
- Home Study
-

5 **What is a PSG?**

- Sleep study
- Collection of parameters
- Includes
  - EEG Electroencephalogram (brain)
  - EOG Electrooculogram (eyes)
  - EMG Electromyogram (muscles)

6 **What is a Home Study?**

- Typically for sleep apnea
- (HSAT) Home Sleep Apnea Testing
- Sleep staging required for some
- Much fewer parameters and equipment
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7 **Automated Sleep Staging**

- Manual Sleep Staging Requires Tech
- Scoring Guides from AASM
- Some use many parameters
- Some use very few parameters

8 **Presentation Outline**

- Background
  - The Single Channel EEG

  - Signal Processing
  - Categorization
- Methods and Results
- Conclusion and Future

9

10 **The EEG**

- Electrodes on the head
- Two Electrodes make a channel
- The 10/20 System
- The R&K Standard
- The AASM
- Brain Waves, Activities, and Events (Markers)
- Amplitude, Frequency, and Other Factors
-

11 **5 EEG Frequencies**

12 **The 10/20 System**

13 **Brain Lobes/Regions**

14 **EEG Channels**

15 **Markers to Lobes/Channels**

16 **Sleep Stages**

17 **Stages to Markers**

18 **This Study**

- A Single Channel
- Channel Fpz-Cz
- 30 Second Epochs
- REM Sleep Stage

19

20 **Signal Processing**

- A brainwave is a signal
- Fourier Series
- EEG Waves
- Time-Frequency Signal Analysis
- Wavelets
-
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21 **Fourier**

22 **EEG Waves**

23 **Time-Frequency Analysis**

- Short-Time Fourier Transform
- Wavelet Transform
- Choi-Williams Distribution
- Wigner-Ville Distributions

24 **Wavelet Transforms**

25 **Mother Wavelets**

26 **Wavelet Transform Modifications**

- Continuous Wavelet Transform
- Discrete Wavelet Transform
- Wavelet Packet Tree
- Multilevel Discrete Wavelet
- Many More

27 **This Study**

- Multilevel Discrete Wavelet Transform with Daubechies Order 2 Mother Wavelet

28

29 **Classification**

- Classification Algorithms
- Artificial Neural Networks (ANNs)
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30 **Classification Algorithms**

- Support Vector Machine
- Hidden Markov Model
- ANN

31 **Artificial Neural Networks**

- Feedforward Backward Propagation
- Deep Feedforward Networks
- Deep Belief Networks
- Multilayer Perceptrons
-

32 **Linear Regression**

33 **Gradient Descent**

34 **Linear Regression Nodes**

35 **Sigmoid Function**

36 **Logistic Regression Nodes**

37 **SoftMax**

38 **Artificial Neural Network**

39

40 **Methods**

- Dataset
- EDFbrowser
- epochs.py
- softANN.py

41 **Dataset**

42 **Epochs.py**

43 **softAnn.py**

44 **Results: Train**

45 **Results: Predict**

46

47 **Conclusion**

- Untested Factors
- Categorizing REM is not possible yet
- Testing more nights
- Categorizing Not REM is possible
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48 **Future**

- EEG Channel
- Sleep Stage
- Epoch length
- Wavelet Transforms
- Neural Networks

49 **References**

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