**EEG Microsleep Characterization based on Self-Organizing Feature Maps**

**Introduction**

Analysis of EEG - Segments accompanied by Slow Eye Movement (SEM) for Microsleep Research based on the Extraction of 47-dimensional Feature Vectors using Discrete Fourier Transform.

Aim 1: Comprehensive Characterization of Microsleep Events based on 2 Seconds EEG-Segments.
Aim 2: Performance of Self-Organizing Feature Maps (SOM) for Clustering of Data with high Noise.
Aim 3: Estimation of the Number of Clusters and the Cluster-Prototypes with an automatic Method.

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**Simple Evaluation**

Winner Frequency for a Self-Organizing Feature Map with 30x40 Neurons

- Artificial Gauss-Mixture Data
  - 1652 Feature Vectors
  - 5 Clusters
  - 47 dim. Feature Vectors
- Recorded SEM-EEG Data
  - 1652 Feature Vectors
  - unknown Number of Clusters
  - 47 dim. Feature Vectors

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**Enhanced Evaluation**

Unified Distance Matrix (U-Matrix) [Ultsch et al., 89]

Method for the Visualization of Distances between topological adjacent Prototype Vectors

\[
dy(x,y) = |w_{xy} - w_{xy,y}| \quad dx(x,y) = |w_{xy} - w_{xy,x}|
\]

\[
dx(x,y) = \frac{1}{2} \left[ |w_{xy,y} - w_{xy,y}| - |w_{xy,x} - w_{xy,x}| \right]
\]

\[
U = \begin{bmatrix}
  u(1,1) & u(1,2) & \cdots & u(1,5) \\
  u(2,1) & u(2,2) & \cdots & u(2,5) \\
  \vdots & \vdots & \ddots & \vdots \\
  u(5,1) & u(5,2) & \cdots & u(5,5)
\end{bmatrix}
\]

- Method for Image Segmentation
  - Steps:
    1) Smooth the Function \(U(x,y)\)
    2) Set initial Ground Level \(h_{\text{min}}\)
    3) Mark all Minima Regions
    4) Flood the Minima Regions
    5) Install water-dividing Barriers

**Segmentation**

Segmentation with the Watershed Algorithm [Beucher et al., 79]

Method for Image Segmentation

1. Smoothe the Function \(U(x,y)\)
2. Set initial Ground Level \(h_{\text{min}}\)
3. Mark all Minima Regions
4. Flood the Minima Regions
5. Install water- Barriers

**Results**

The "Segmented U-Matrix Method" is applied to the SEM-EEG Data Set in order to evaluate the Number of Clusters as a Function of the Ground Level \(h_{\text{min}}\). Alpha-Burst Microsleeps are only one type among the Diversity of EEG-Microsleep Events. Therefore, the depicted Result represents an Extension of the current scientific Knowledge

- a: without Generation of new Minima Regions
- b: with Generation of new Minima Regions

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