NEUROPRO
WINAM

Epilepsy prediction and
EEG biomarker detection

neuropro.ch/winam

# About WINAM

WINAM is a simple yet unique EEG analysis method for identifying neural biomarkers of different brain states in both health and disease. To date, it has been optimised for the detection and prediction of epileptic seizures and is under investigation in a number of other conditions.

## Key features

- Simple, general framework
- Large input parameter space
- N-gram feature extraction
- Patient-specific machine learning
- Self adaptive dynamic operation

With the advent of affordable wireless headsets, EEG monitoring devices are set to become the wearable for the brain. Monitoring brain health for mental wellness will become as ubiquitous as activity tracking for physical fitness. NeuroPro's advanced SaaS tools for mobile streaming of EEG data into the cloud enable the development of a big data community, to build collective knowledge to better understand the brain and neurological disorders.

Analysing such potentially vast data sets necessitates advanced algorithms designed to run intelligently in a standardised and unsupervised manner to deliver accurate and repeatable results. WINAM has been developed to address these future challenges in EEG research and has achieved promising results for epilepsy seizure detection and prediction.

## Technology

### Feature extraction

WINAM is a patented n-gram based pattern detection algorithm. In general, the algorithm scans the input time-series (in this case EEG) by dividing it into overlapping segments of a user-defined length. These segments are further divided into a number of overlapping sub-intervals of another shorter, user-defined length. The amplitudes of the time-series in each sub-segment are quantised based on their amplitude to create n-gram pattern for each sub-segment.

Patterns that repeat more than twice are considered significant and the samples contained within each significant pattern are deducted from the total number of samples within each sub-segment. The "anomalies ratio" is then computed for each sub-segment by dividing the number of remaining samples (ie: those not included in any pattern) by the total number of samples in the sub-segment. This ratio is computed for each sub-segment and the resulting vector for each segment used as a feature vector for machine learning.

### Machine learning

In the case of epilepsy seizure prediction and detection, models are built to machine learn the optimum WINAM input parameters to maximise sensitivity and minimise false alarm rates on a patient-specific basis. Input data containing the known location of seizures is used to train the algorithm. The algorithm is tested on data that was not used for training. The procedure iterates over all seizure and non-seizure data sets, isolating them for testing one at a time. Finally, it averages the results of each case to obtain the overall accuracy of the model for a set of input parameters. This training and testing is performed on each patient independently in order to capture patient-specific signal variations.

### Self adaptive dynamic operation

NeuroPro's data ecosystem infrastructure is designed to handle the continuous optimisation of WINAM's biomarker detection and prediction algorithm such that it learns and adapts dynamically as the system captures missed seizures and false alarms.

> *A device that allows some kind of warning gives you control,* ***and the one thing that people with severe epilepsy don't have is control****. If you're granted it, then your life is transformed.*
>
> Person with epilepsy

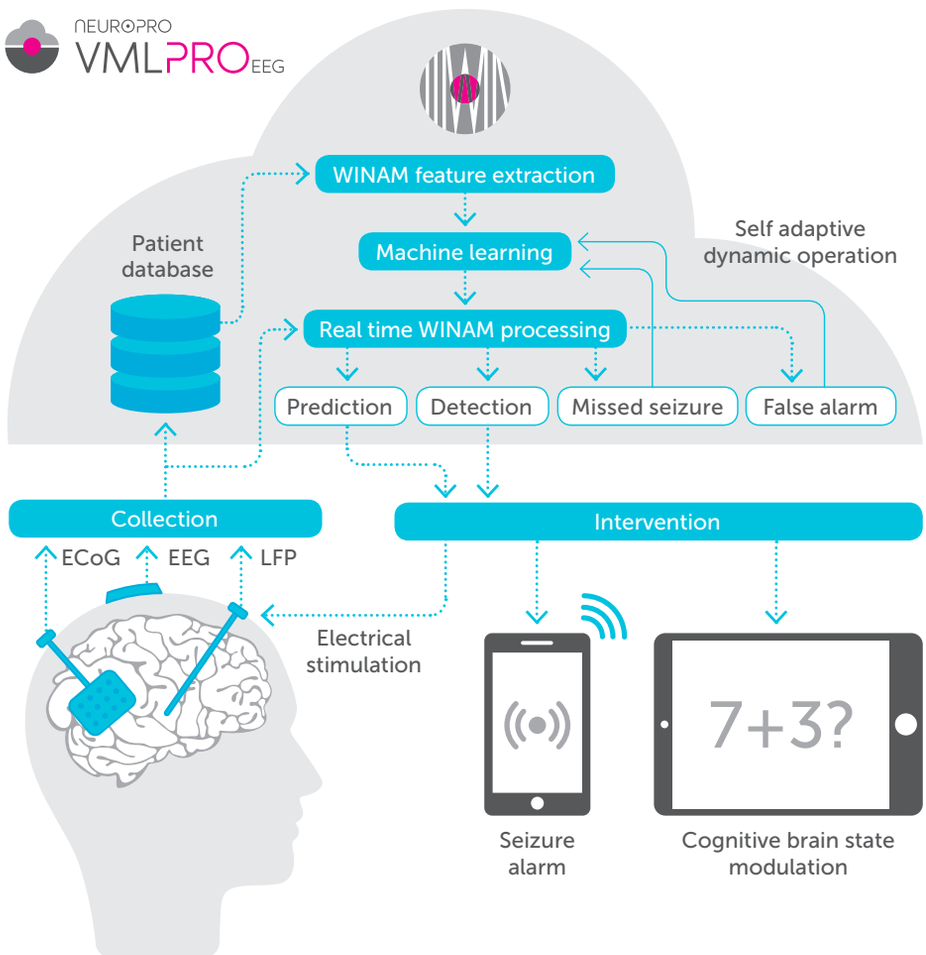


**Diagram:**
Overview of integrated closed-loop epilepsy prediction/detection and intervention system

## Results

The WINAM algorithm has been initially tested on the Freiburg epilepsy database which includes annotated long-term EEG and EGoG recordings from 20 epilepsy patients. The algorithm displays promising prediction accuracy, achieving 100% prediction success with 0 false alarms in greater than 50% of patients tested.

Prediction accuracy and false alarm rates among the remaining patients also outperformed 'next-best' prediction approaches.

The machine learning layer is critical since optimising the prediction accuracy requires determining unique WINAM input parameters for each patient. Thus, our complete analytical approach determines, for each patient;

- The optimal prediction window (the time before seizure onset),
- The subset of n-gram patterns that best predict seizure onset
- The interval lengths over which to determine the anomalies ratio and thus the input feature vectors

Given these promising results, WINAM may be used to integrate EEG capture, analysis and seizure prediction with intervention to develop closed loop systems to directly improve the management of epilepsy and improve patient outcomes.

## Applications

- Seizure prediction
- Seizure detection
- EEG biomarker detection
- EEG research
- Neuromonitoring

## Ongoing projects

- Validation of n-gram methods for seizure detection and prediction
- Development of an EEG early warning system for impending epileptic seizures
- Development of a body-sensor system for long-term monitoring, prediction of, and intervention in epileptic seizures

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## Who we are

NeuroPro incorporates specialists from the fields of computer science, neurophysiology, bioengineering, and product and user-interface design. This combination of skills allows us to adopt an informed inter-disciplinary approach to the specific challenges facing those working in brain science.

Our tools for monitoring and analysing brain activity will contribute to accelerating brain research by supporting researchers, clinicians and innovators in pushing the boundaries of brain science and its applications.

Our tools provide an advanced platform for the development of a wide range of health and wellness applications from supporting the development of brain observatories to remote telemonitoring, patient led research, neurofeedback and cognitive wellness. Additionally, NeuroPro's tools are relevant to innovative entertainment, lifestyle and interaction solutions driven by brain computer interface technologies.

## Contact us

Partnership is a key element in the way we work. We collaborate with globaal leaders in the design, development and implementation of our products and welcome new collaborations.

**NeuroPro AG**
Fraumünsterstrasse 16
8001 Zürich, Switzerland
T +41 44 229 6007
E info@neuropro.ch

**www.neuropro.ch**