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BIOSIGNAL ANALYSIS

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GUGER TECHNOLOGIES

medical & electrical engineering

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Offline Biosignal Processing and Analysis under MATLAB

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BIOSIGNAL ANALYSIS

Highlights

- extensive biosignal analysis package with modular toolboxes
- via mouse-click from raw data import, pre-processing, parameter extraction and sophisticated analyses to publication-ready plots
- integration of advanced user specific methods and algorithms
- history/journal files and convenient batch processing mode for automatic analysis of group study data
- comfortable data editor and powerful 2-D and 3-D result viewer/editor
- full support for almost any 3rd party data formats

base version: Data file I/O, Visualization, (Pre-)processing, Artifact treatment, Transformations, ...

Data visualization
Data ruler, Undo (1-step, multi-step), Journal file, Full header access, High speed data scrolling (trial x channel/channel x trial), Assign and edit data attributes and markers, Epoching (free/multi trial/multi channel mode), Data scoring, Quick analyses of epochs, Assign comments, Attribute jumper, Data status monitor, Data player, Zoom, Data scaling (auto, amplifier, manual, type specific)

Data file I/O and Printing
Import filter: MATLAB, EDF, BKR, ASCII, RDF, CNT, TFM, MOBILAB, Block import, Full support for 3rd-party formats, Export ASCII, Assign class labels, Plot data, Printer options

Transformation
Cut trials-samples-channels, Sort data, Merge data sets, Arithmetic operations, Data triggering (on multiple triggers), Untrigger data

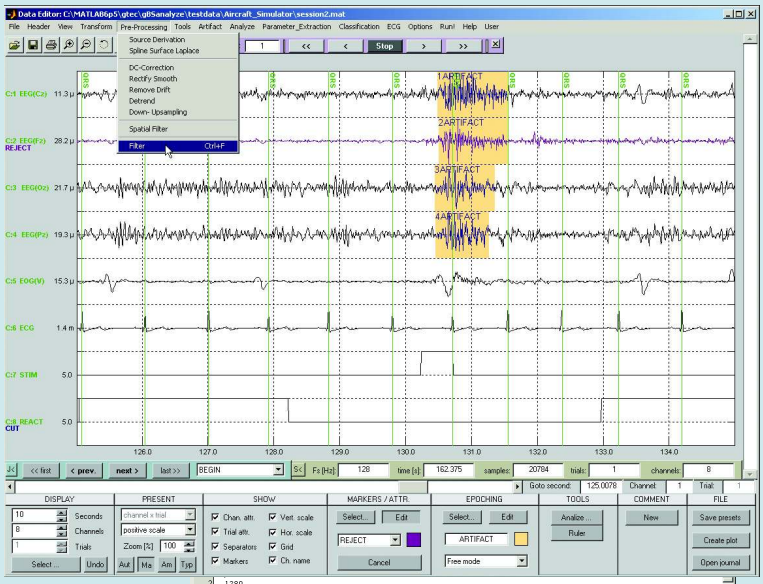
Pre-processing
DC-correction, Smoothing/Rectifying, Data detrending, Remove drift, Down- and upsampling, Filter data (highpass, lowpass, bandpass, bandstop), Filter design with graphic support, Spatial filtering

Tools
Stimulus/response detector, Reaction time analysis, Single trial analysis

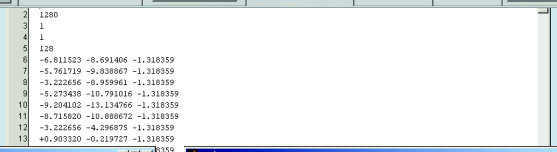
Artifact treatment
Overflows, Zerolines, Eventfinder with automatic attribute/marker assignment, Artifact removal with ICA/spatial filters

Analyze
Independent Component Analysis (ICA), Principal Component Analysis (PCA)

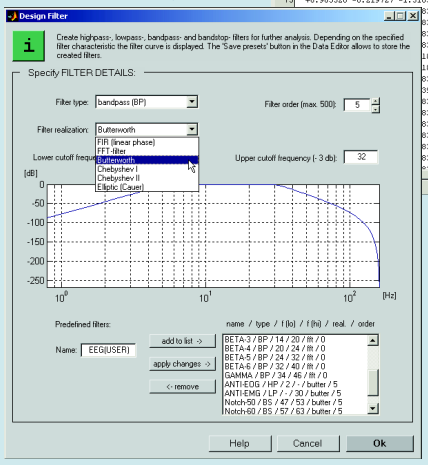
Batch mode
Automatic generation of journal files, Batch mode processing for multiple data sets



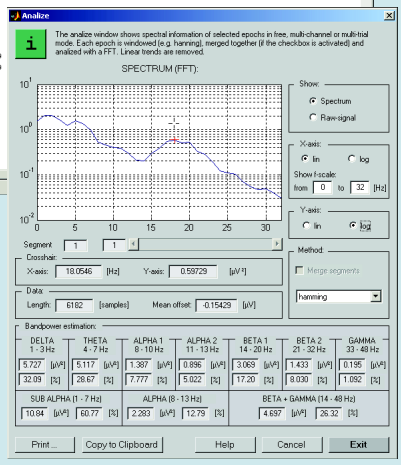
data editor showing multi-modal biosignals



easy import and export of almost any data formats



design your filters



quick analyses of selected data segments (epochs)

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general analysis: Signal analyses, Parameter extraction, 2D-results, ... (included in EEG and ECG toolbox)

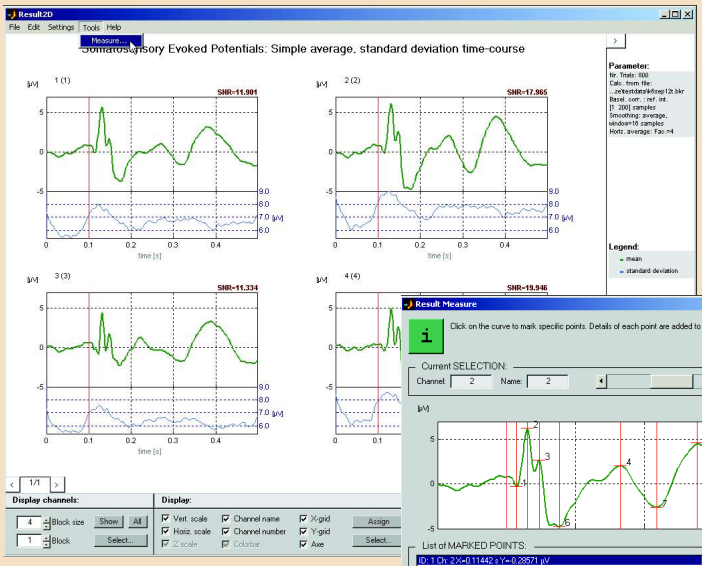
Analyze functions
Data quality (histogram, distribution and statistic measures),
Average across trials (EP analysis, baseline correction, SNR, graph comparison, ...),
Power spectrum analysis and significance test of differences,
Wavelet analysis

Parameter extraction
Adaptive autoregressive (AAR) parameters
Signal variance, Bandpower,
Exponential window, Cross correlation and CC-based template matching

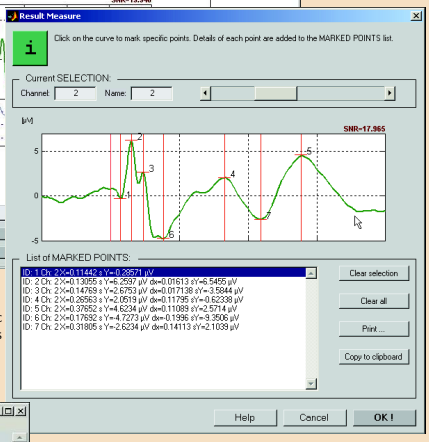
Result visualization
2D plots of analysis results, Layout editor, Copy and measure, Background image, ASCII export, Clone plots, Topography, Header editor

Pre-processing
Source derivation

Montage creator
Edit topography/electrode positions according to the international 10-20 system or free electrode system, Specify source derivations (BIP/CAR/LAR/LAP,...), Edit geometry data

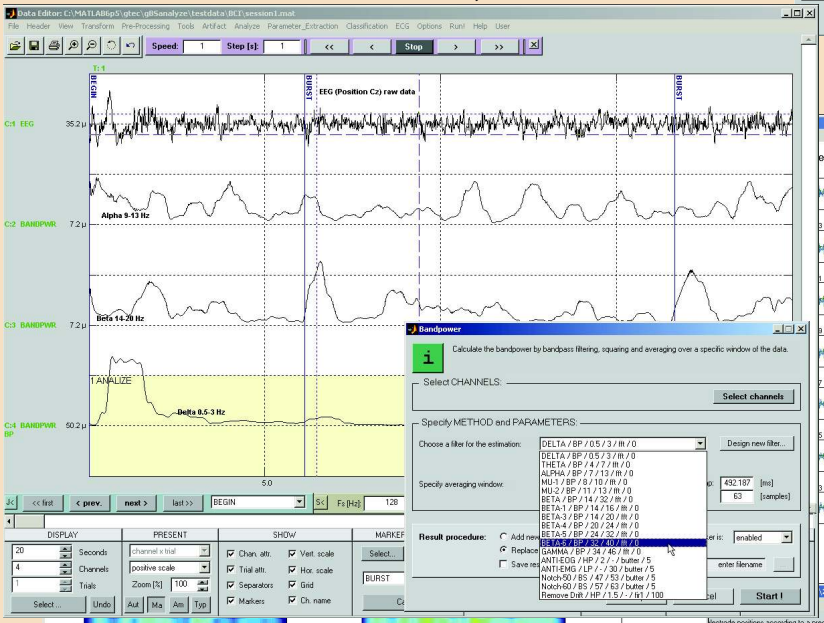


SSEPs following electrical median nerve stimulation mesured at different electrode positions

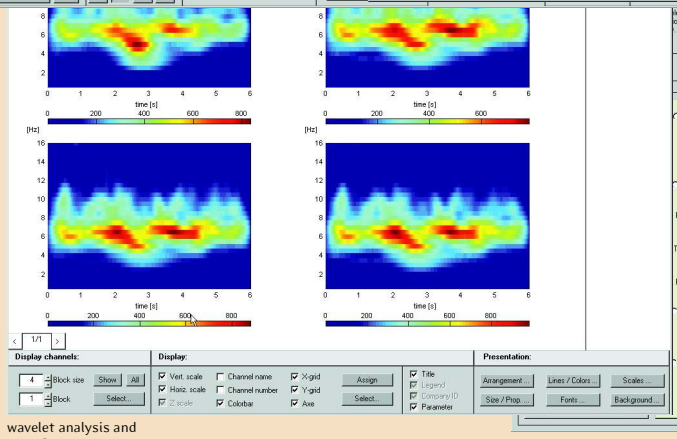


measure characteristic points in the result plots

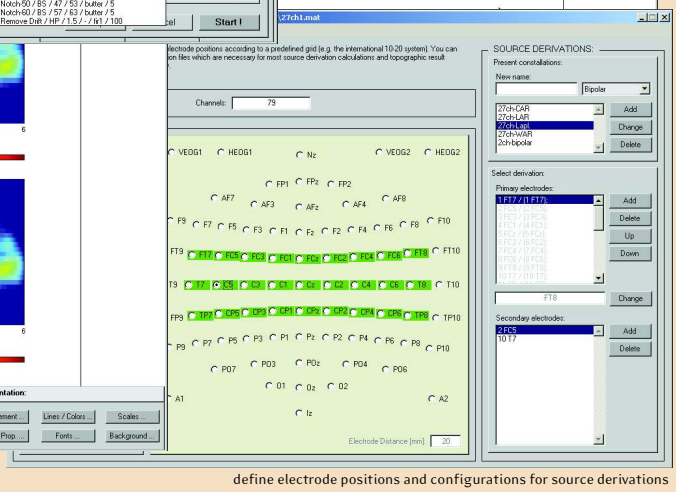
extract different parameters from biosignal raw data for further analyses



result plots for recordings with up to 128 channels



wavelet analysis and time-frequency maps



define electrode positions and configurations for source derivations

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ECG toolbox: Specialized Analyses for the Electrocardiogram

ECG specific analyze functions
Coherence, Event-related coherence, Event-related ECG changes

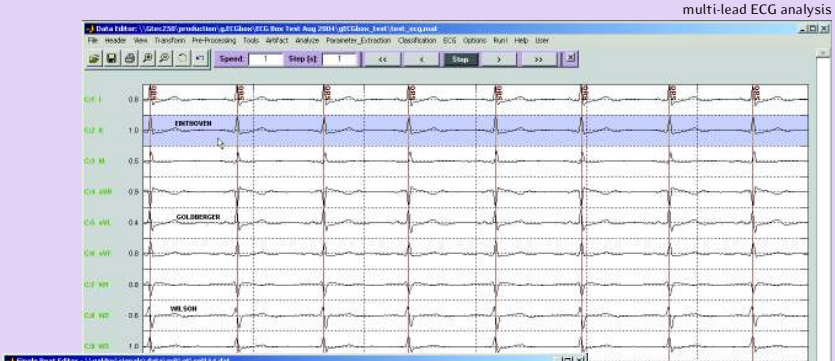
QRS/R-peak detector
QRS complex detector with deviant complex detector, Automatic detection, classification and counting of normal beats, atrial/ventricular extrasystoles, bundle branch block, artifacts, ...

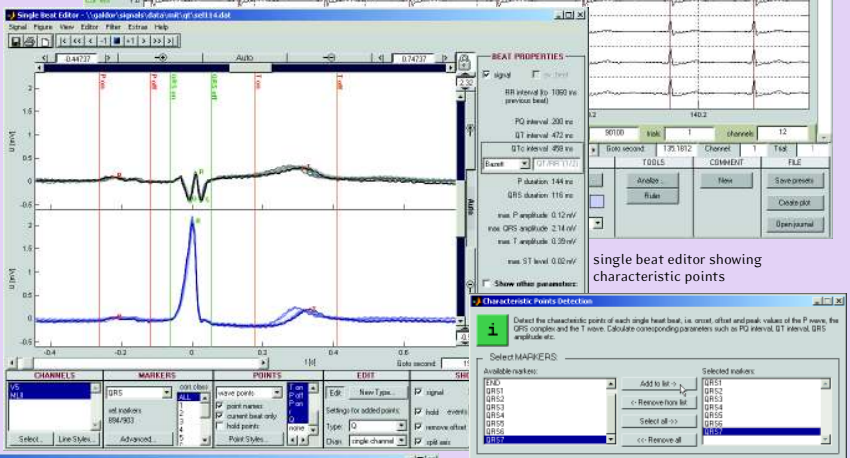
Parameter extraction
Tachogram

HR/HRV (heart rate / heart rate variability)
HR/HRV time domain parameters, Geometric measures, RR difference measures, Segmented measures, Poincarè plots,
HR/HRV frequency domain parameters, Power measures, Normalized measures, HRV time-frequency maps

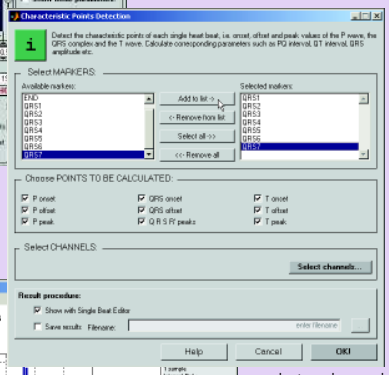
ECG single beat analysis
Single beat editor, Automatic beat-by-beat detection of characteristic points: P_{on}, P, P_{off}, QRS_{on}, Q, R, S, QRS_{off}, T_{on}, T, T_{off}, Extraction of corresponding intervals, durations, amplitudes/levels and other parameters,
Time evolution plots for parameters, QT-interval and ST-segment analysis for identification of pathological changes, Recording reports

multi-lead ECG analysis



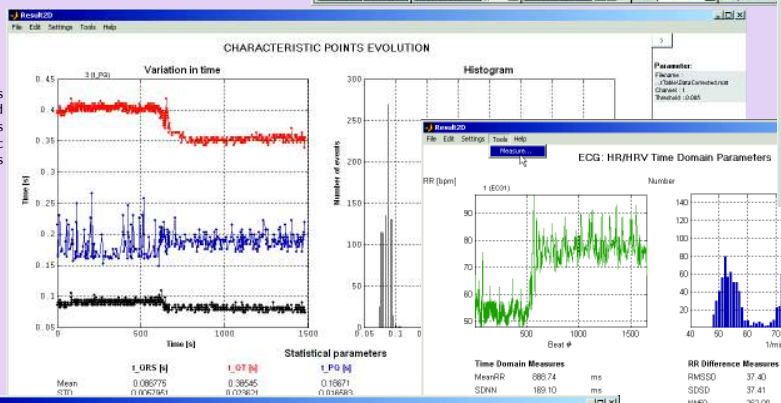


single beat editor showing characteristic points

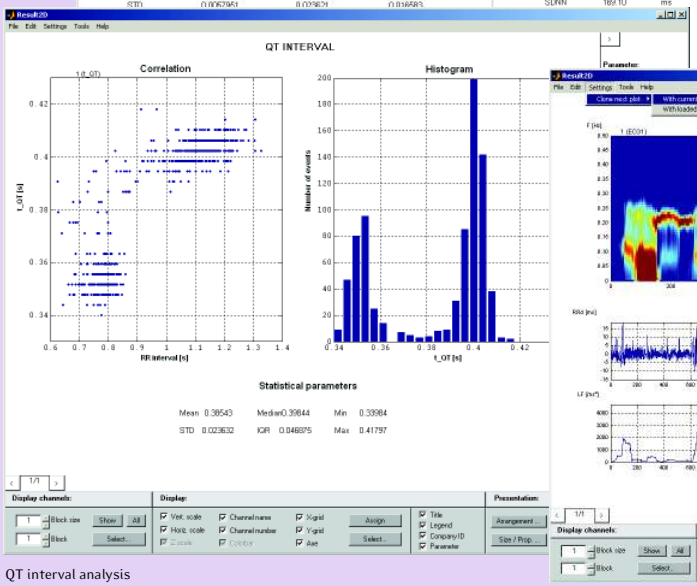


select markers and characteristic points

time courses and histograms of specific parameters

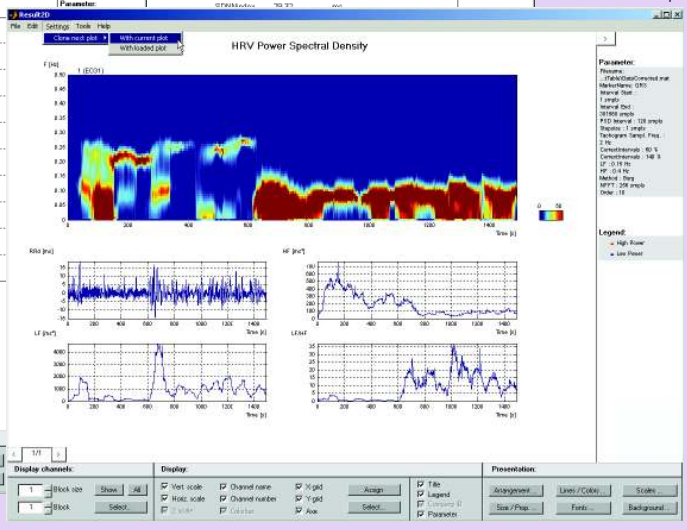


HR/HRV (heart rate, heart rate variability) parameters in the time domain



QT interval analysis

HRV: time-frequency maps



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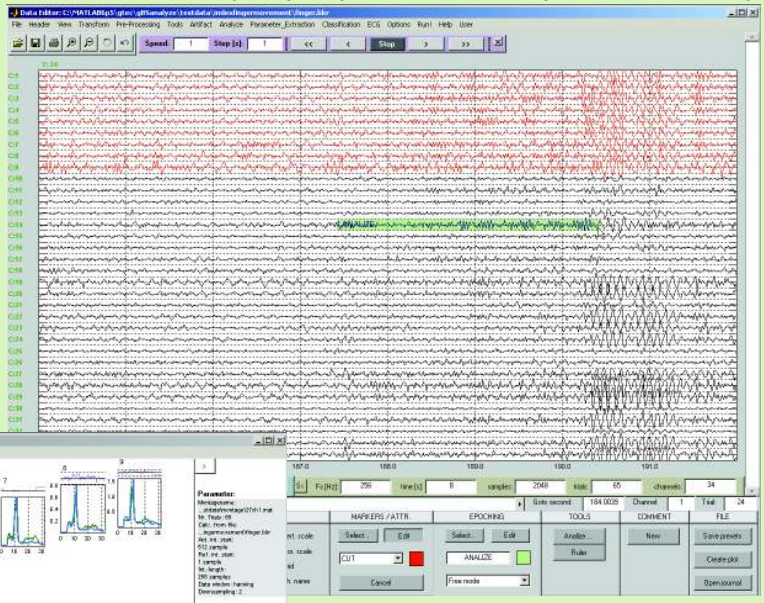
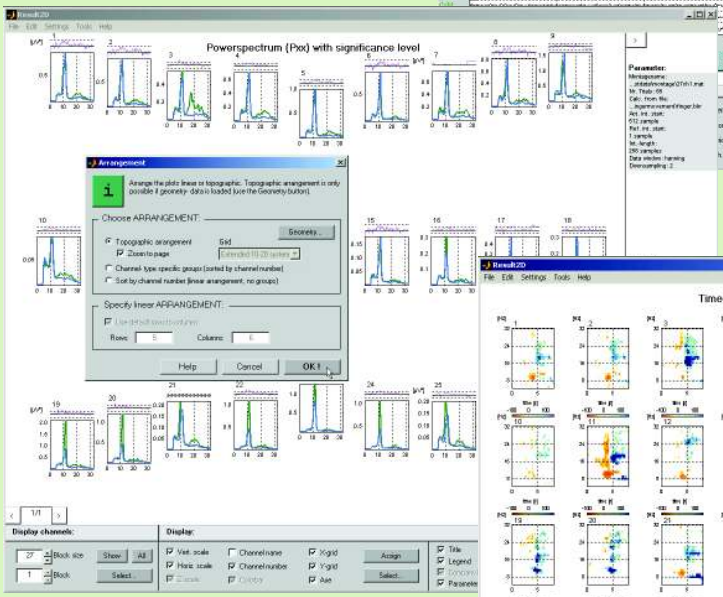
EEG toolbox: Specialized Analyses for the Electroencephalogram

EEG specific analyze functions
Coherence,
Event-related coherence,
ERD/ERS analysis with significance test,
ERD/ERS time-frequency maps with bootstrap test for significance,
ERD/ERS time-frequency maps with complex demodulation,
ERD/ERS time-frequency maps with wavelets,
ERD/ERS time-frequency maps with Hilbert transformation,
Common spatial patterns (CSP)

Parameter extraction
Hjorth parameters,
Barlow parameters,
Running fractal dimension,
Temporal and spatial complexity

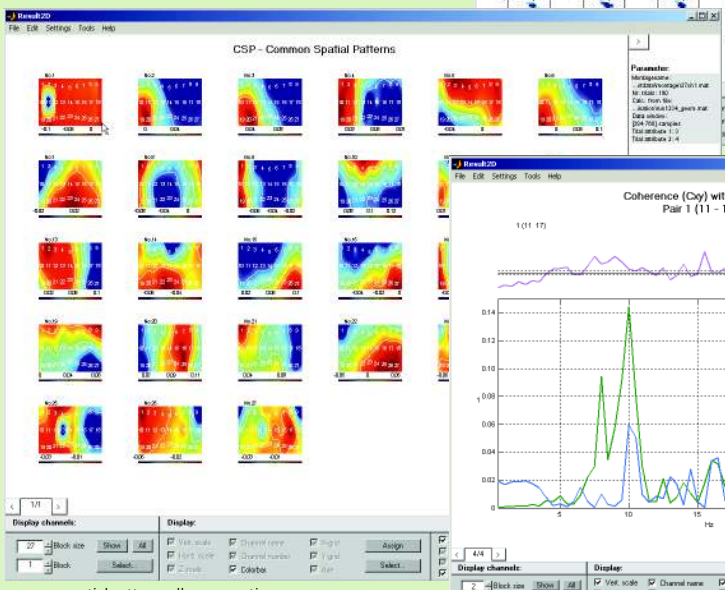
easy handling, viewing, scoring, transformation and processing of multi-channel EEG recordings



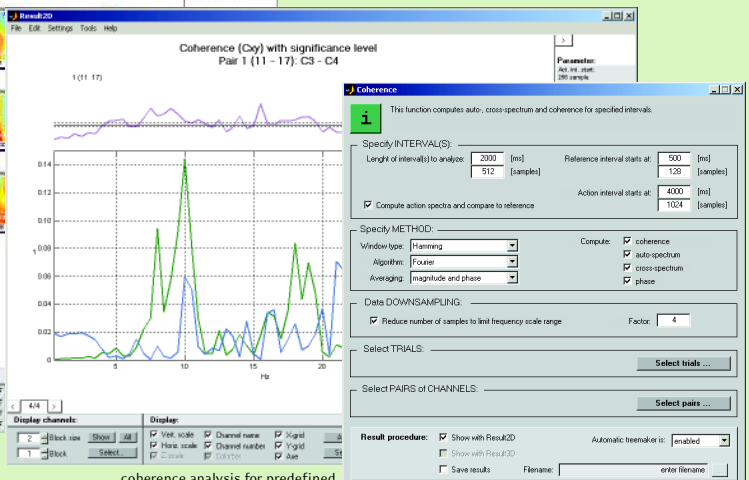


topographic arrangement of multi-channel results: spectral comparison with significance test

ERD/ERS time-frequency maps: a comprehensive overview of the dynamic of oscillatory EEG components (with bootstrap test)



common spatial patterns allow generating new time series for optimal distinction between classes (maps display CSPs with topographic information arranged according from the most distinctive to the least one)



coherence analysis for predefined pairs of channels (and comparison with significance test)

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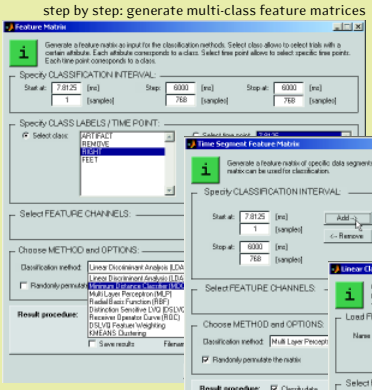
classify toolbox: Biosignal classification methods

Tools
Generate feature matrix, Generate time segment feature matrix,
Test classifier, Apply classifier,
Store classifiers for online application (biofeedback, BCI, ...)

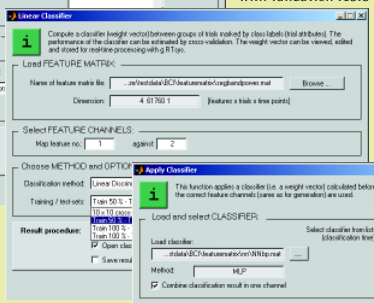
Methods
Multi-class linear discriminant analysis,
Minimum distance classifier,
Backpropagation neural network,
Receiver operator curves,
Radial basis function,
Distinction sensitive learning vector quantization (DSLVQ),
DSLVQ for feature weighting,
K-means clustering

step by step: generate multi-class feature matrices

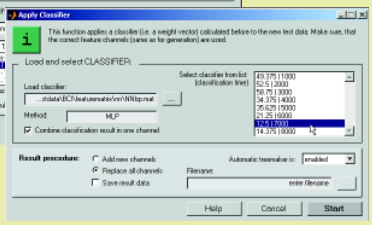


discriminate between specific time segments within trials

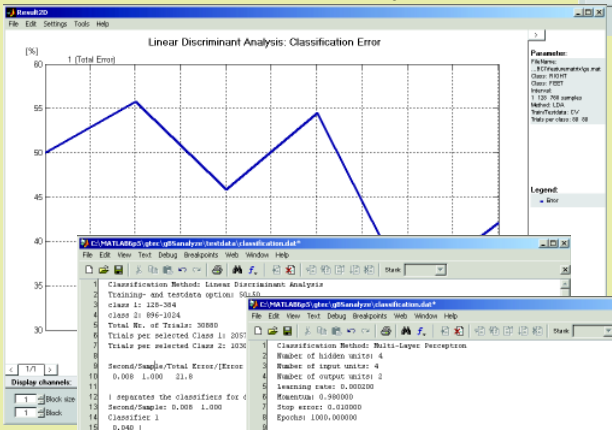
compute classifiers with various methods and evaluate them with validation tests



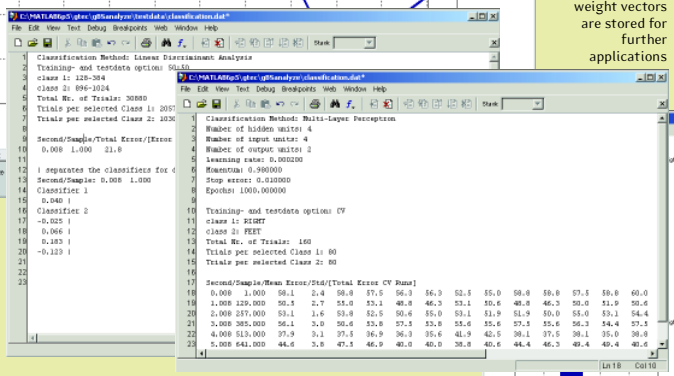
apply a classifier computed from training data to new test data sets



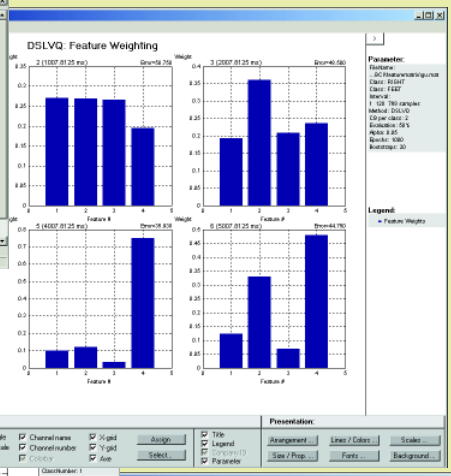
the validation of a classifier leads to a classification error (e.g. as a function of time)

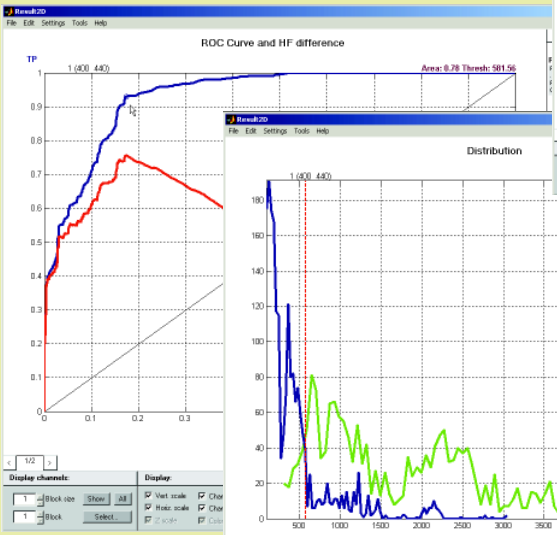


classifier reports and weight vectors are stored for further applications

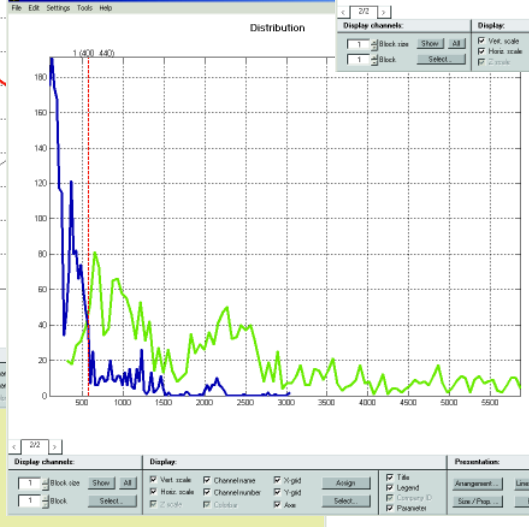


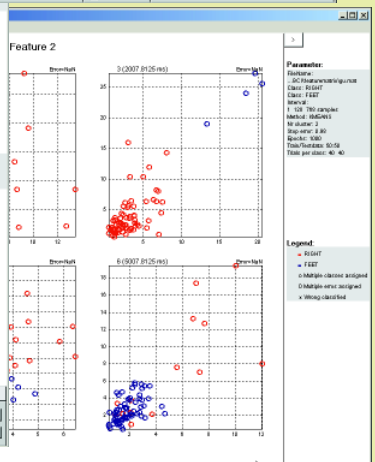
DSLVQ feature weighting helps to identify the most important features for a discrimination task



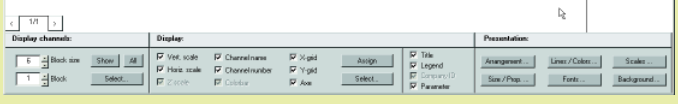


ROC curves can be used for threshold optimization to achieve the maximum discrimination between hits and false





KMEANS clustering finds the optimal position of codebook vectors in k-means



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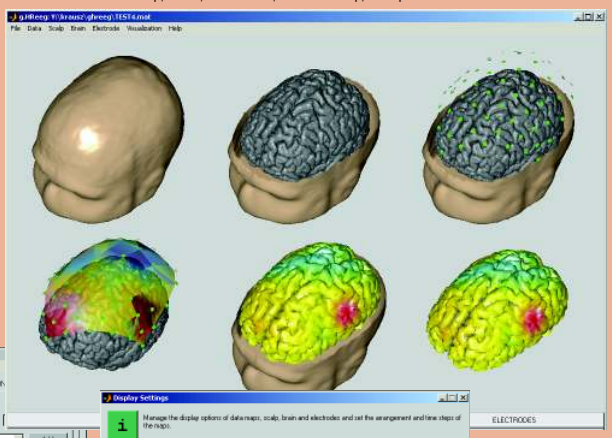
high resolution EEG toolbox: Realistic anatomical multi-layer models and result mapping

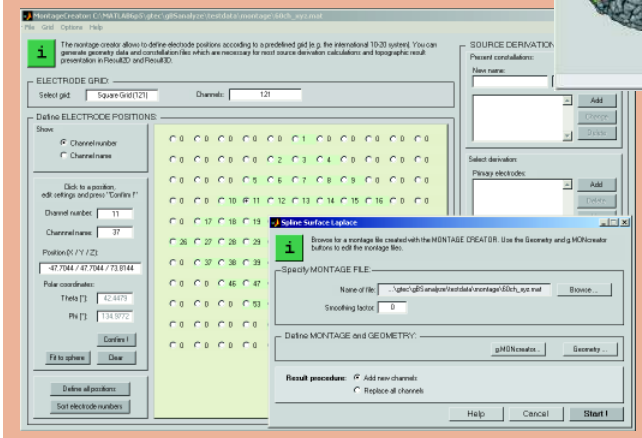
Pre-processing
High resolution spline Laplacian derivations for ERD/ERS, ERP, ...

Anatomical modeling
Generation of realistic anatomical multi-layer models from segmented CT/MRI data, Fit electrode positions to models, Edit geometry data

Result mapping
2D and 3D mapping of results for different model layers, Edit transparency and colors, Free rotation of models/maps, Generate time series

different model layers and combinations:
scalp, brain, electrodes, data on scalp, interpolation of data on brain surface

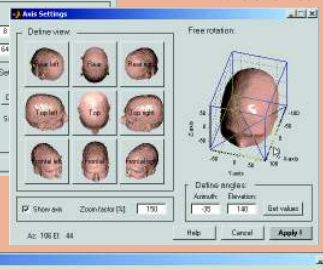




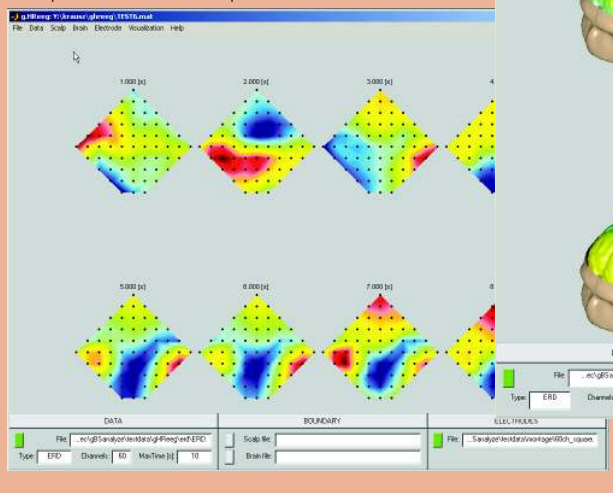
define (or import) electrode positions for spline surface Laplacian derivations

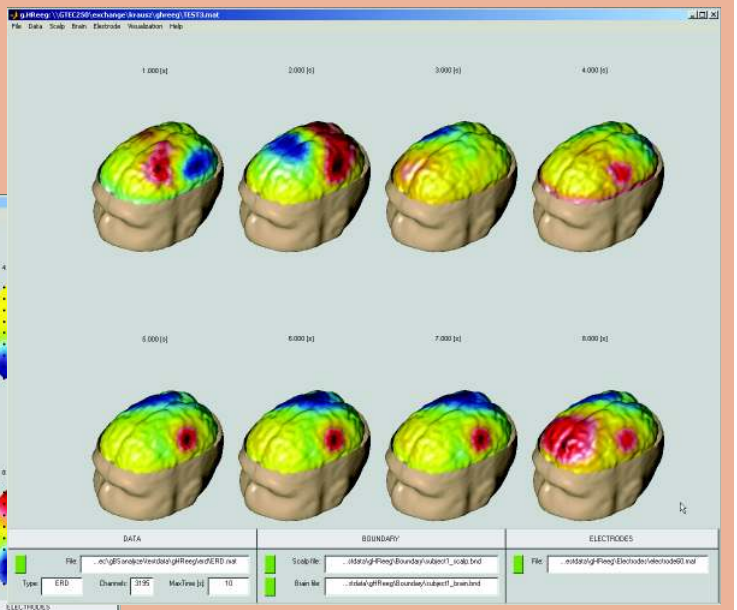
specify colors, parameters and transparency for the different layers

define the view or use the free rotation tool



2D-map time series with electrode positions





high resolution mapping of an ERD/ERS time series with realistic head (and brain) model generated from segmented MRIs

subscription and support:

Subscription
g.*BSanalyze* comes with a hardlock for an unlimited single-place license or classroom license. The software includes a 1-year subscription with free updates. The subscription can be renewed after 1 year.

Support
On-demand implementation of user specific methods/algorithms. Full e-mail/phone support with minimum delay. Full support for 3rd party data formats.

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Clinical research
BCI research, Mobile systems

EEG / ECG / EMG / EOG
Biosignal amplifiers

Data Acquisition

Real-Time
Data acquisition
Processing
Analysis
Neurofeedback

Signal Analysis
Offline biosignal
Processing and
Analysis

Stimulation
Experimental paradigm
Generation / Presentation

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