OpenSignals (r)evolution
File Formats Description

OSF 080517

FEATURES

> Data visualization & recording
> Feature extraction plugins with reporting
> Multiplatform support
> User-friendly GUI

APPLICATIONS

> Psychophysiology
> Biomedical projects
> Computer science
> Electrical engineering
> Human-Computer Interaction
> Robotics & Cybernetics
> Physiology studies
> Biomechanics
> Biofeedback

GENERAL DESCRIPTION

OpenSignals records data in ASCII tab delimited files (Fig. 1) and/or in the modern and highly efficient HDF5 format (Fig. 2). If the same format is followed, any third-party software can also export or record data in such a way that OpenSignals may be used as visualizer.

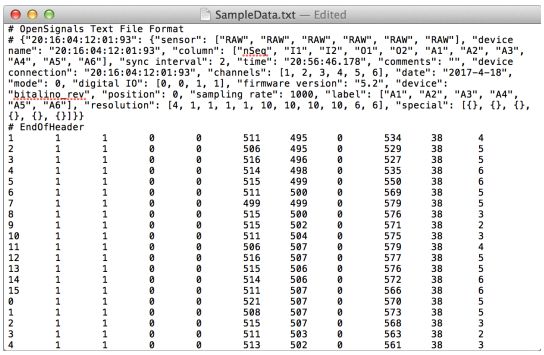

Fig. 1. Example ASCII file for BITalino (r)evolution; ***Col. 1:*** *Sample sequence number (4-bit) generated on the device to facilitate the detection of missing data;* ***Col. 2 & 3:*** *State of the digital inputs I1 & I2;* ***Col. 3 & 4:*** *State of the digital outputs O1 & O2;* ***Col. 5-:*** *Raw data for each analog input acquired during the recording session (in this case A1-A6).*

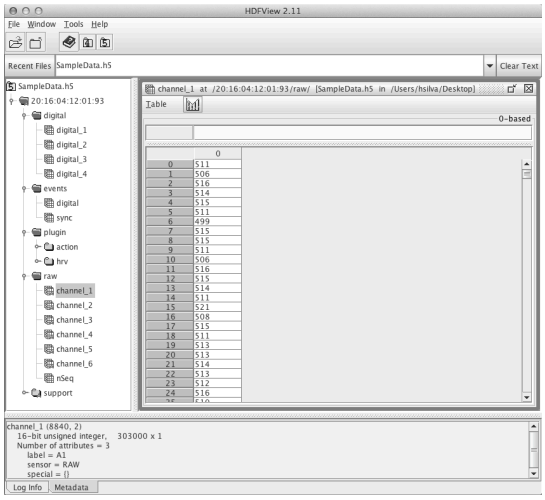

Fig. 2. Example of a recording stored in HDF5 format.

PLUX – Wireless Biosignals, S.A.
Av. 5 de Outubro, n. 70 – 8.
1050-059 Lisbon, Portugal
plux@plux.info
http://www.plux.info/

REV A

METADATA FIELDS SUMMARY

Field	Description
channels	Set of analog inputs selected for acquisition in the recording session that generated this file (last columns of the file)
column	Meaning of each column (in ASCII files) or group with acquired data (in HDF5 files) for a given device[1]
comments	User-defined text with notes or other content of interest to the file
date	Day, month and year in which the file was recorded
device	Type of recording device used to collect the data (e.g. biosignalsplux, BITalino (r)evolution)
device connection	Logical address used to establish a connection with the device[2]
device name	Friendly name manually assigned by the user to the device
digital IO	Set of digital channels available in this device (`0 – Input; 1 – Output`)
firmware	Version of the embedded software running on the device that acquired the data
label	Array with labels manually assigned by the user to each of the analogs channels
mode	Specifies the acquisition mode in which the device was used (`0 – Regular acquisition; 1 – Multiple synchronized devices; 2 – Started by a triggering signal`)
resolution	Resolution with which each of the columns (in ASCII files) or group with acquired data (in HDF5 files) are represented
sampling rate	Number of samples per second with which data has been acquired by the device on each channel
sensor	Array with the type of sensor connected to each analog port (e.g. as selected from the options available in the device configuration panel on OpenSignals)
special	List of non-standard channels acquired (e.g. SpO2 sensors with I2C interface connected on biosignalsplux hubs).
sync interval	Time interval (in seconds) at which a digital signal is sent by a "pacemaker" thread to a single device (used when the sync mode in on OpenSignals for synchronized data acquisition using multiple devices)
position	Order in which the block of columns corresponding to a given device appears in each line of the file (`0 – First sequence of columns; 1 – Second sequence of columns; etc.`)
time	Time at which the first sample was received by the software

ASCII TEXT FORMAT

OpenSignals ASCII text files have two parts, namely a header section and data section.

The header section has 3 header lines, each starting with the pound (#) character, given that it is automatically ignored by ASCII text file loading functions in common scientific computing programming languages (e.g. `loadtxt` in Python).

The header section begins after the line with the content `"# OpenSignals Text File Format"` and ends after the line `"# EndOfHeader"`. The second line has the metadata stored as a JSON object containing each device's MAC address as top-level keys. For each top-level key, there is a JSON object as value, containing the acquisition settings used for that

[1] i.e. **nSeq** is the sample sequence number generated on the device, **Ix** is the state of digital input x, **Ox** is the state of digital output x, and **Ax** is the raw data sampled by the device.

[2] e.g. **AA:AA:AA:AA:AA:AA** represents a connection over a Bluetooth socket, **0.0.0.0:0000** represents a connection over TCP/IP, and **COM1** or **/dev/tty.BITalino-AA-AA-DevB** represents a connection over serial port.

device in the recording session that produced the file in the form of key / value fields (described earlier).

JSON has been chosen as the metadata representation format, given that in most scientific computing languages it can be directly unraveled as a dictionary, and it has parsers available for most mainstream programming languages.

SampleData.txt

```
# OpenSignals Text File Format
# {"20:16:04:12:01:93": {"sensor": ["RAW", "RAW", "RAW", "RAW", "RAW", "RAW"], "device
name": "20:16:04:12:01:93", "column": ["nSeq", "I1", "I2", "O1", "O2", "A1", "A2", "A3",
"A4", "A5", "A6"], "sync interval": 2, "time": "20:56:46.178", "comments": "", "device
connection": "/dev/tty.BITalino-01-93-DevB", "channels": [1, 2, 3, 4, 5, 6], "date":
"2017-4-18", "mode": 0, "digital IO": [0, 0, 1, 1], "firmware version": "5.2", "device":
"bitalino_rev", "position": 0, "sampling rate": 1000, "label": ["A1", "A2", "A3", "A4",
"A5", "A6"], "resolution": [4, 1, 1, 1, 1, 10, 10, 10, 10, 6, 6], "special": [{}, {}, {},
{}, {}, {}]}}
# EndOfHeader
```

Fig. 3. Example of an ASCII text file header.

On the data section, each column contains the signals labeled in the `column` field (see the caption on Fig. 1 for an example). To facilitate automated post-processing of the data, the resolution with which each column is recorded is stored in the `resolution` field (e.g. useful for a specific sensor's transfer function found in the corresponding sensor datasheet).

If the acquisition includes multiple devices, the metadata is stored following the same logic for each device, side by side, according to the `position` header field.

HDF5 FORMAT

OpenSignals HDF5 files comprise one group for each device used, represented by its MAC address. Each device's group includes metadata fields containing the acquisition settings used for that device in the recording session that produced the file (described earlier) and 5 sub-groups:

> **digital:** includes a dataset for each digital channel (input channels followed by the output channels);
> **events:** includes a dataset for digital events and dataset for sync events;
> **plugin:** includes a group of datasets for each plugin used/processed;
> **raw:** includes a dataset for the sample sequence number generated by the device and a dataset for each analog input selected for acquisition (each analog dataset includes the label and sensor type attributes).
> **support:** includes a group of datasets with support information (mean, standard deviation, ...) for each zoom level available for each channel, either analog or digital (`t`: initial time for the sample group; `mean`: average, `sd`: standard deviation; `mx`: minimum value; `Mx`: maximum value; `mean_x2`: average of the sample group's 2nd power).

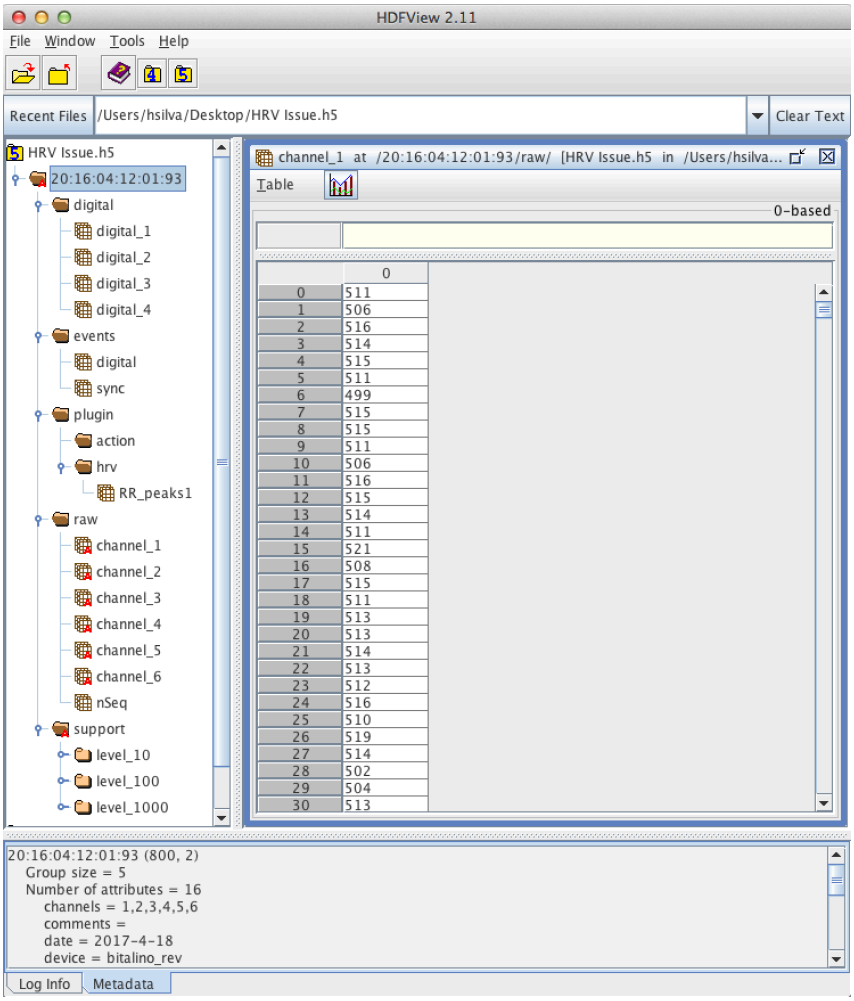

Fig. 4. Example of an HDF5 file structure.