

# **Behavioral Observation Research Interactive Software (BORIS) user guide**



**BORIS is an easy-to-use event logging software for video/audio coding and live observations.  
BORIS is a free and open-source software available for GNU/Linux, Windows and Mac OS X.**

**version 5.1.3**

[www.boris.unito.it](http://www.boris.unito.it)

# Contents

<b>Follow BORIS</b>	<b>3</b>
<b>Legal</b>	<b>4</b>
<b>Install BORIS</b>	<b>4</b>
Linux	4
Microsoft-Windows	4
Mac OS	4
VirtualBox virtual appliance	4
<b>Launch BORIS</b>	<b>4</b>
<b>Create a new project with BORIS</b>	<b>5</b>
Set an ethogram	6
Define the subjects	12
Define the Independent variables	13
Observations' tab	14
Converters' tab	14
<b>Open an existing project with BORIS</b>	<b>15</b>
<b>Observations</b>	<b>16</b>
Create a new observation	16
Observations list	21
Delete observations	24
Import observations from a project file	24
<b>Coding your media</b>	<b>24</b>
Media controls are available in the toolbar	24
<b>Ethogram</b> widget in the main window	25
<b>Subjects</b> widget in the main window	26
<b>Media player</b> widget in the main window	26
<b>Events</b> widget in the main window	27
Record an event	27
Frame-by-frame mode	29
<b>Exporting events data</b>	<b>29</b>
Export events	30
Export aggregated events	30
Export events as behavioral strings	31
Export events as Praat TextGrid	31
Extract sequences from media files	31
Export transitions matrix	32
<b>Playback menu</b>	<b>33</b>

Jump	33
Zoom	33
<b>Tools</b>	<b>33</b>
Geometric measurements	33
Coding pad	35
Transitions flow diagram	36
Re-encoding and resizing a video file	37
Project server	38
<b>Coding map</b>	<b>38</b>
The Behaviors coding map	38
The Modifiers coding map	42
<b>Analysis</b>	<b>43</b>
Time budget	43
Synthetic time budget	45
Plot events	46
Inter-rater reliability	48
<b>Preferences</b>	<b>48</b>
General preferences	49
FFmpeg framework	50
Frame-by-frame mode	50
Spectrogram	51
Plot colors	51
<b>Various</b>	<b>52</b>
Citing BORIS	52
Bug reports and features request	52
Docking	52
<b>Acknowledgement</b>	<b>53</b>
Valid keys for triggering behavior	53

## Follow BORIS

BORIS web site: [www.boris.unito.it](http://www.boris.unito.it)

BORIS GitHub repository

BORIS twitter feed

BORIS discussion group

BORIS Facebook page

BORIS Google+

# Legal

Copyright 2012-2017 Olivier Friard - Marco Gamba

**BORIS** is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2, or any later version.

**BORIS** is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the [GNU General Public License](#) for more details.

## Install BORIS

BORIS can be installed following instructions on the BORIS site at [download page](#)

### Linux

BORIS is available as a DEB package for DEB based distributions based (like Debian and Ubuntu). After installation you will find BORIS in the **Education** sub-menu.

You can also run BORIS from sources. See the download page for details about the dependencies to install.

### Microsoft-Windows

BORIS is available for Windows in 32-bit and 64-bit versions. Check your OS before downloading.

Two versions are available: **BORIS Setup** and **BORIS Portable**

The **BORIS Setup** will install BORIS on your system (the default install path is located in your home directory, you do not need administration rights to install BORIS).

The **BORIS Portable** will NOT install BORIS on your system but will run from a directory (find and launch boris.exe). Use this version if you want to test a new version of BORIS for example.

### ***BORIS debugging version***

Use this version if you want to report bug. In this case you should include screenshots or copy of the terminal output. This version will NOT install BORIS in your system.

### Mac OS

BORIS is available for Mac OS only in 64-bit version (from >= 10.8)

### VirtualBox virtual appliance

If you want to try BORIS without installing it you can download the [VirtualBox virtual appliance](#) from the BORIS site. In this case you must first install the [VirtualBox](#) virtualizer from Oracle (released under GPL 2).

## Launch BORIS

Start BORIS by clicking on its icon. For launching BORIS from sources see the BORIS web site. When launching BORIS for the first time it may take some time to show up. Please be patient!

The main window of BORIS will show up. The toolbar with media player commands is disabled for now.



#### **WARNING**

On Mac OS X 10.9 and above, launching can be stopped according to the `Security & Privacy` settings of your computer. They can be changed opening `System Preferences...` > `Security & Privacy` > `General` and selecting the option `Anywhere` in the frame `Allow apps downloaded from`. Alternatively you can repeat the operation right-clicking on the BORIS icon and then clicking `Open` in the following two dialog boxes.

#### **WARNING**

On Microsoft-Windows, launching can be stopped by a `Security warning: The publisher can not be verified. Are you sure you want to run this software?` Click the `Run` button to launch BORIS.

At the first launch, BORIS will ask you to allow the automatically check for new version. Internet access is required for this feature. If you choose **Yes** BORIS will check for new version about every 15 days. This option can be changed on the **Preferences** window (See [general preferences](#))

You can launch BORIS from command line by specifying the project file to open as the first argument.

## **Create a new project with BORIS**

The BORIS project file is the container for all information related to the project. It contains the **ethogram**, the **independent variables**, the **subjects definition**, the **behaviors coding maps**, the **converters** and all **observations** data. The save menu option (**File > Save project** or **Save project as ...**) will save the project in a path in your local file system. You can also activate the **automatic backup** feature (see **Preferences**).

#### **NOTE**

**It is very important to do regular backups of your project files to prevent the lost of data.** Software can be reinstalled but your data could quite possibly be lost for ever.

BORIS allows creating an unlimited number of projects but only one project can be opened at a time.

A video tutorial about creating a project is available at <https://www.youtube.com/watch?v=l97Dny5hFOE>

To create a new project, under the menu **File**, select **New project**. You can determine your project name by writing in the **Project name** field in the **Information** tab. Once the project will be saved, the **Project file path** will show the full path to your project file. **Date** will automatically set on the current date and time, but you can alternatively set this info on your media date and time, or whatever you prefer. **Description** can host all the relevant information about your project, can be also left empty. **Time format** can be alternatively set to **seconds** or to **hh:mm:ss.mss**. This choice can be changed at anytime under **File > Preferences** (for MAC users, **BORIS > Preferences**) > **Default project time format**.



## Set an ethogram

See <https://en.wikipedia.org/wiki/Ethogram> for ethogram definition.

Switching to the **Ethogram** tab, you can alternatively:

- set your ethogram from scratch;
- import an existing ethogram from another BORIS project;
- import an ethogram from a JWatcher global definition file (.gdf).
- import an ethogram from a plain text file

Information Ethogram Subjects Independent variables Observations

Behavior type	Key	Code	Description	Category
11 State event	↑	M	Manipulate	Otter handles an object in its environment (Hasenjager, 2011)
12 State event	↑	F	Look for food	Otter looks for food in the environment
13 State event	↑	S	Sniff	Otter moves the nose and head movement back and forth while not engaged in the rub behavior (Ethol, 2015)
14 State event	↑	L	Locomotion	Otter moves from place to place
15 State event	↑	I	Interact with enrichment	Otter interacts with enrichment
16 State event	↑	E	Eat	Otter consumes food
17 State event	↑	S	Swim	Otter swims in the water
18 State event	↑	D	Drink	Otter consumes water found in its environment
19 State event	↑	D	Dig	Otter uses front legs to move sand, stones on the ground (Ethol, 2015)
20 State event	↑	D	Defecate	Otter eliminates fecal matter (Ethol, 2015)
21 State event	↑	Z	Stomp	Otter stomps its rear legs alternately up and down several times before and after defecates/urinates (Ethol, 20...
22 State event	↑	U	Urinate	Otter eliminates urine
23 State event	↑	C	Chase	Otter chases other animals
24 State event	↑	C	Carry objects	Otter carries objects or food by holding them against the cheek with one front paw while hobbling on three le...
25 State event	↑	B	Breed	Otters are engaged in copulatory activities (Hasenjager, 2011)
26 State event	↑	Q	Allgroom	Otter licks or scratches with forepaws or hind-paws another river otter's fur (Ethol, 2015)
27 State event	↑	A	Alert	Otter is stationary and directs its attention towards something or someone (Hasenjäger, 2011)
28 Point event	↑	V	Vocalize	Otter vocalizes
29 Point event	↑	Y	Yawn	Otter yawns

Add behavior  
Clone behavior  
Remove behavior  
Remove all behaviors  
Behavioral categories  
  
Exclusion matrix  
Import behaviors from a BORIS project  
Import from JWatcher  
Import from text file

Cancel OK

## Set your ethogram from scratch

Clicking on the **Add behavior** button you can add a new row in the *Ethogram* table and behavior type will be automatically set to **Point event**.

### Behavior types

2 types of behaviors can be defined:

- **Point event** behavior when the behavior has no duration. The behavior will be coded by pressing the defined keyboard key (see below) or by clicking to the corresponding row in the Ethogram table.
- **State event** behavior when the behavior has a duration. The behavior start and stop will be coded by pressing the defined keyboard key (see below) or by clicking to the corresponding row in the Ethogram table. These behaviors **must** have a start event and a stop event.

You can switch between **State event** and **Point event** at your convenience from the **Behavior type** column. You can also add a **Coding map** to either a **State event (State event with coding map)** or a **Point event (Point event with coding map)**; see the "Coding map" section for details).

An existing behavior can be duplicated using the **Clone behavior** button. Its code have then to be changed. On a selected behavior, click on the **Remove behavior** button to remove. The **Remove all behaviors** button will clear the **Ethogram** table. Both the above-mentioned operations must be confirmed when prompted.

Behavioral codes (**Code** column) can be sorted alphabetically by checking the **Alphabetical order** checkbox. Alternatively they can be sorted manually by using the **Move up** and **Move down** buttons.

### Categories of behaviors

Defining categories of behaviors can be usefull for the analysis of coded events (for example the time budget analysis). Click the **Behavioral categories** button and add a the categories of behaviors. Behaviors can then be included or not in a defined category.



### **Set keys and codes**

For each behavior you have to set a keyboard key (**Key** column) that will be then used to code the behavioral events. You can choose whether you want to set a unique key for each behavior or use the same key for more than one behavior. In the case you set the same key for more than a behavior, BORIS will pause your coding and ask which of the behavior you want to record. The keys are case-insensitive.

#### **important**

**Do not use the / and \* keys! They are reserved for the frame-by-frame mode.**

In the **Code** column, you have to add a unique code for each behavior. Duplicated codes are not accepted and BORIS will warn in red about duplicates on the bottom left of the *Ethogram* tab. The code can be an alphanumeric string (which must not include the pipe character | ).

The **Category** column allow you to include the behavior to a predefined category.

The **Description** of your behavior is optional. The **Description** column can be useful to add information about a specific behavior, its characteristics (e.g. to standardise observation between different users) or to refer to external information (e.g. reference to a previous ethogram).

The following three columns (**Modifiers**, **Exclusion**, **Coding map**) cannot be edited from the *Ethogram* table.

### **Set the modifiers**

Modifiers can be used to add attributes to a behavior. A single behavior can have two or more modifiers attached (e.g. "play" may have "solitary" or "social" as modifiers). The use of modifiers can be convenient to significantly reduce the number of keys and simplify the behavioral coding.

3 types of modifiers are available: **Single selection**, **Multiple selection** and **Numeric**. **Single selection** modifiers allows the observer to select only one modifier in the list. **Multiple selection** allows to select more modifiers from the list. **Numeric** allows to input a numeric data.

In BORIS modifiers can also be added in different modifier sets [e.g. "play, social" may have a modifier set (#1) for "brothers" and another (#2) for "sisters"]. In the case of using sets of modifiers, you can select one/more modifier for each set.

To add modifiers to a behavior, you need to double-click the **Modifiers** cell corresponding to the behavior you want to add the modifiers to.

Click the **Add a set of modifiers** button.



Set a name for the new modifiers set (new in v. 4) by typing it in the **Set name** edit box. Setting a modifiers' set name is not mandatory.

Select the modifier type using the **Modifier type** combo box. You can choose between **Single selection**, **Multiple selection** and **Numeric**

Within a set of modifiers, you can add and remove modifiers using the **Modifier** field and clicking on the **right-arrow** button (to add) and the **Remove modifier** button (to remove). The selected modifier can be edited using the **left-arrow** button. The **Key code** box can be used to set a shortcut key for the modifier (optionnal).

The modifier position into the modifiers' set can be manually set using the **Move modifier up** and **Move modifier down** buttons.

You can add and/or remove sets using the buttons **Add set of modifiers** and **Remove set of modifiers**.

The position of a modifiers' set can be customized (using the **Move set left** and **Move set right** buttons)

Modifiers can not contain the following characters: **(|), `~!**

Example of a **multiple selection** modifiers set:



Many values can be selected together.

Example of a 2 sets of modifiers:





Click **OK** to save modifiers in the **Ethogram** table.

### **Set the exclusion matrix**

The occurrence of an event (State or Point) can exclude the occurrence of a state event. This can be set using the **Behaviors exclusion matrix** window, which can be opened clicking on the **Exclusion matrix** button. BORIS will ask for including **Point events** or not and a new **Exclusion matrix** window will open.

Exclusive behavior may be selected by checking on the corresponding cell in the automatically-generated matrix. We suggest to work on the **Exclusion matrix** when all the behaviors have been added to your ethogram.

Example of an **exclusion matrix**:

In the previous example the Locomotion behavior will exclude **Alert**, **Allgroom**, **Breed**, **Carry objects** ...

During the observation, the excluding event will stop all the current excluded state events one millisecond before the occurrence of the event.

### **Import an ethogram from an existing project**

Behaviors within an ethogram can be imported from an existing BORIS project (.boris) using the **Import behaviours from a BORIS project** button. BORIS will ask to select a BORIS project file and whether imported behaviors should replace or be appended to the **Ethogram** table. Imported behaviors will retain all the previously defined behavior parameters (namely Behavior type, Key, Code, Description, Modifiers and Exclusion information).

## **Import an ethogram from a JWatcher global definition file (.gdf)**

Behaviors can be imported from a JWatcher global definition file (.gdf) using the **Import from JWatcher** button. BORIS will ask to select a JWWatcher file (.gdf) and whether imported behaviors should replace or be appended to the **Ethogram** table. Behavior type and exclusion information for the behaviours imported from JWWatcher have to be redefined.

## **Import an ethogram from a plain text file**

Behaviors can be imported from a plain text file using the **Import from text file** button. The fields must be separated by TAB, comma (,) or semicolon (;). All rows must contain the same number of fields.

The fields will be interpreted as:

- field #1: event type (point or state)
- field #2: key (case insensitive)
- field #3: code (must be unique)
- field #4: behavior category (empty if no category)
- field #5: description (optional)

All fields after the 5th will be ignored.

BORIS will ask to select a plain text file (by default: \*.txt \*.csv \*.tsv) and whether imported behaviors should replace or be appended to the **Ethogram** table. The missing information for the behaviours imported from text file have to be redefined.

## **Export the ethogram**

The entire ethogram can be exported in various formats (TSV, CSV, XLS, ODS, HTML). See **File > Edit project > Ethogram tab > Export ethogram**

## **Define the subjects**



BORIS allows coding behaviors for different subjects within a single observation. The **Subject** table allows specifying subjects using a **Key** (e.g. the "K" on your keyboard), **Subject name** (e.g. "Kanzi"), **Description** (e.g. male, born October 28 - 1980). In this case, pressing "N" will set "Nina" as the focal subject of the behavioural coding. Pressing "N" again will deselect "Nina" and set to "no focal subject". The definition of one or more subjects is not mandatory. Addition, removal and sorting of the subjects follows the same logic of the *Ethogram* table (see **Set your ethogram from scratch** for info). The subjects can also be imported from an existing BORIS project using the **Import Subjects from a BORIS project**.

## Define the Independent variables

edit project

Information		Ethogram		Subjects		Independent variables		Observations	
	Label	Description		Type	Predefined value		Set of values		
1	Location	Location where observations were made		text	44° 55' 59" N - 7° 25' 18" E				
2	Temperature	Average temperature of the day (°C)		numeric					
3	Visitors	Visitors per day		numeric					
4	Weather	Meteorological conditions		value from set	sun		sun,rain,cloud		

Add variable  
Remove variable  
Import variables from a BORIS project

Label: Location  
Description: Location where observations were made  
Type: text  
Predefined value: 44° 55' 59" N - 7° 25' 18" E

Cancel OK

BORIS allows adding information about the observation using **Independent variables**. This can be used to specify factors that may influence the behaviors (e.g. group composition, temperature, weather conditions) but will not change during a single observation within a project. Each independent variable can be defined by a **Label** (e.g. weather), a **Description** (e.g. weather conditions), a **Type** (*text*, *numeric*, *value from set* or *timestamp*).

The values of a set are defined in the **Set of values** column separating the available values with a comma (,). Please note that the first value of the set will be selected by default. It should be useful to define a NA value as first value of every set.

The values for the independent variables will be asked when creating a new observation. Addition, removal and sorting of the independent variables follows the same logic of the **Ethogram** table (see **Set your ethogram from scratch** for info). The independent variables can also be imported from an existing BORIS project using the **Import Variables from a BORIS project**.

Example of independent variable defined as "set of values"



The predefined value must be contained in the set of value.

## Observations' tab

The **Observations** table in BORIS shows information about all the previous observations within a project. A selected "Observation" can be removed using the "Remove observation" button (you will be prompted for confirmation). This operation cannot be undone and deleted observations cannot be recovered once the project is saved. The **Observations** table shows four columns **id Date Description Media**.

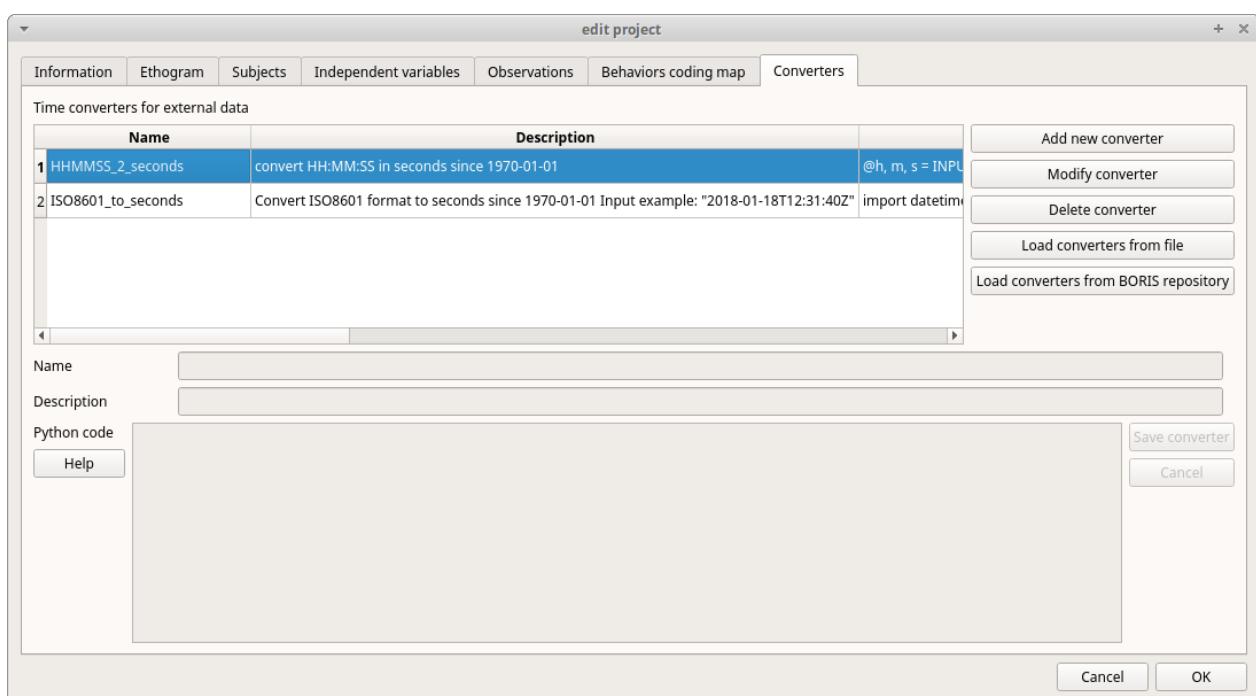
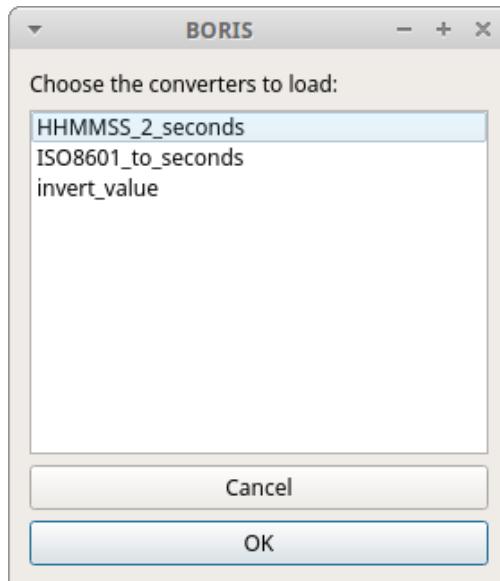
## Converters' tab

Converters are used for plotting external data when the timestamp values are not expressed in seconds. Converters can be written by the user, loaded from file or loaded from the repository of the BORIS web site (<http://www.boris.unito.it/static/converters.json>).



## Load converters from BORIS web site

Click **Load converters from BORIS repository** and select the converters to be added to your project.



The converters loaded in your project can be then selected for converting timestamp (or other values) in external data file (See [converters](#))

## Open an existing project with BORIS

### IMPORTANT

Due to changes in modifiers format all the projects created with v. 4+ will not be suitable for previous version of BORIS. The v. 4 will open projects created with previous version and convert them. A copy of your old project will be kept.

To open an existing BORIS project, select the menu **File > Open project**. A BORIS project file is a container for all information related to a set of observations as the ethogram, the independent variables,

and the subjects. BORIS allows creating an unlimited number of projects but only one project can be opened at a time.

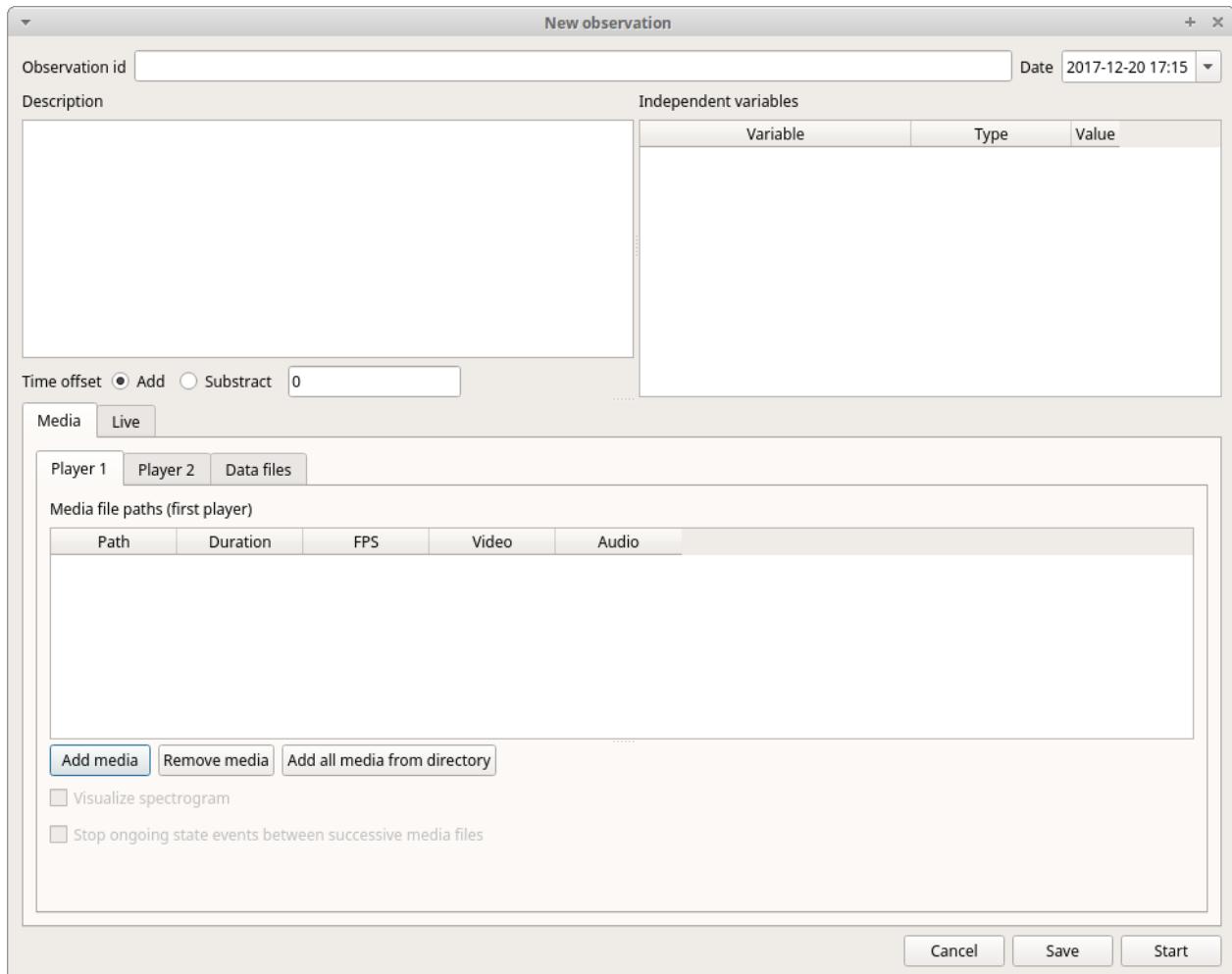
## Observations

### Create a new observation

A video tutorial about making an observation is available at <https://www.youtube.com/watch?v=ef-d6WEc0po>

To create a new observation you must first [Create a new project with BORIS](#) or [Open an existing project with BORIS](#).

Clicking on **Observations > New observation** will show the **New observation** window.



This window allow adding various observation data:

- a mandatory **Observation id** (must be unique across all observations in the open project);
- **Date**, which will be automatically set on the current date and time, but you can alternatively set this info on your media date and time, or whatever you prefer.
- **Description**, which can host all the relevant information about your observation, but can be also left empty.
- **Independent variables** (e.g. to specify factors that may influence the behaviors but will not change during the observation within a project). See the [independent variables](#) section for details.

- **Time offset.** BORIS allow specifying a time offset that can be added or subtracted from the media timecode.

You must then indicate if you want to make an observation based on pre-recorded media (audio / video) or a live observation.

### **Live observation**

During the live observation BORIS will show you a timer that will be used for recording time for coded events.

Choose the **Live tab** to make a live observation.

The screenshot shows the 'New observation' dialog box with the 'Live' tab selected. The 'Observation id' field contains 'Live observation demo'. The 'Date' field shows '2018-01-19 10:49'. The 'Independent variables' section contains three entries:

Variable	Type	Value
1 meteo	value from set	clouds
2 temperature	numeric	25
3 Group size	numeric	8

The 'Time offset' section shows 'Add' selected, with a value of '00:00:00.000'. The 'Scan sampling every' field is set to '0 seconds'. At the bottom are 'Cancel', 'Save', and 'Start' buttons.

In the above tab you can select a time for **Scan sampling** observation. In this case the timer will stop at every time offset you indicated and all the coded events will have the same time value.

### **Media based observation**

Click on the **Media** tab to make an obervation based on media.



The **Media tab** contains 3 tabs: **Player 1**, **Player 2** and **Data files**.

Click the **Player 1** tab and add one or more media files using the **Add media** button.

Information about the selected media file will be extracted and displayed in the media list: media file path, media duration (in seconds), number of frames by second (FPS), video stream, audio stream .

If you have to add various media files, you can use the **Add all media from directory** button, in this case all the media files found in the selected directory will be added in the playlist.

The **Remove media** button can be used to remove the selected media files.

All the media types reported at <http://www.videolan.org/vlc/features.html> can be played in BORIS. The media queued in the *Media file paths* will be played sequentially. This means that an event occurring at time  $t_x$  in the media file queued as second (e.g. second\_video.mp4) in the playlist will be scored as happening at time  $t_1 + t_x$  (where  $t_1$  is the duration of the first media file, e.g. first\_video.mp4).

### **Spectrogram visualization**

BORIS allow you to visualize the sound spectrogram during the media observation. Activate the *Visualize spectrogram* check box. BORIS will ask you to generate the spectrograms for all media files loaded in the first player.



The spectrogram visualization will be synchronized to the media position during the observation.



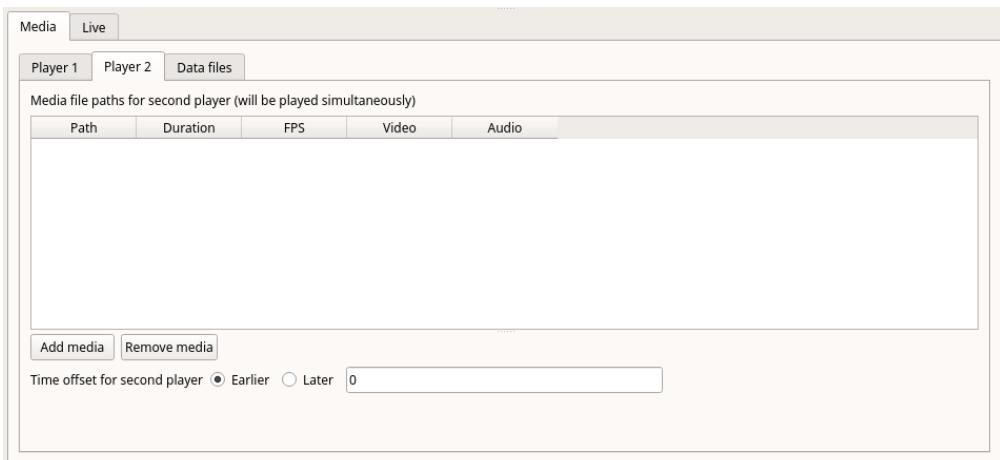
### ***Close current behavior between videos***

If this option is selected BORIS will close all ongoing State events between successive media files.

This option can be useful if you have to code various short media files enqueued in the first player (for example the output of a Camera trap).

### ***Second media player***

You can add a second media that will be played synchronously with the first media player. Click the **Player 2** tab and add the 2nd media. You can set a **Time offset for second player** in order to synchronize it with the first player.



### ***Data files***

You can select one or more external data files to be plotted synchronously with your media. Click the **Data files** tab and use the **Add data file** button to select a data file.

Player 1 Player 2 Data files

Data files to plot

Path	Columns to plot	Plot title	Variable name	Converters	Time interval (s)	Start position (s)	Subtract first value	Color
.....								

Add data file View first rows Show plot Remove data file

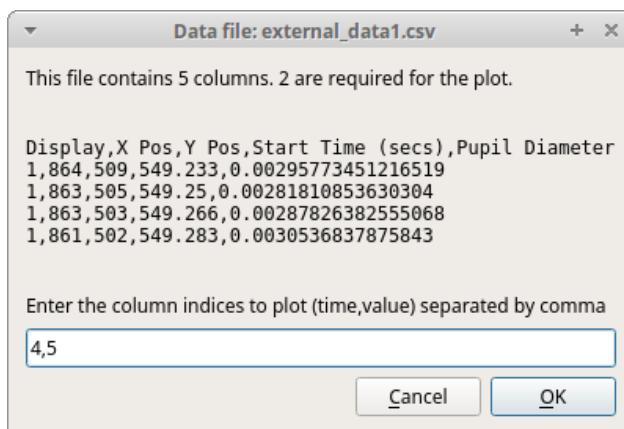
The data file must be a plain text file with at least **2 columns** separated by comma or TAB. One column must contain a timestamp that will be used to synchronize the plot with the media. The sampling rate can be variable.

Example of a plain text data file with 5 columns separated by comma (,):

```
Display,X Pos,Y Pos,Start Time (secs),Pupil Diameter
1,864,509,549.233,0.00295773451216519
1,863,505,549.25,0.00281810853630304
1,863,503,549.266,0.00287826382555068
1,861,502,549.283,0.0030536837875843
1,858,501,549.3,0.00308083021081984
1,856,499,549.316,0.00306266942061484
1,854,499,549.333,0.00305776367895305
[ ... ]
```

In the above example the 4th column contains the timestamp and the 5th the value to be plotted.

Input the index of the column containing the timestamp and the index of the column containing the value to be plotted. The two indices must be separated by a comma (,). Click **OK** to close the window.



A new row will be added in the data files table.

Data files to plot

Path	Columns to plot	Plot title	Variable name	Converters	Time interval (s)	Start position (s)	Subtract first value	Color
1 /home/user/external_data1.csv	4,5	Eye tracker	Pupil diameter		60	0	True	b-

You can modify/complete the following parameters by directly typing in the table cells:

- Columns to plot
- Plot title: the title of the plot
- Variable name
- Converters: Used if the timestamp is not expressed in seconds (see below for details)

- Time interval: The time interval that will be plotted (in seconds)
- Start position: the start position of data for synchronisation with the media (in seconds)
- Subtract first value: if the timestamp does not start with a 0 value you can choose to subtract the first value to all timestamp values.
- Color: the color of the color

You can check if the data from file can be correctly plotted by using the **Show plot** button. If the data are compatible you will see a plot otherwise you will obtain a message with an explanation.

### Converters

If the values in the timestamp column are not expressed in seconds (like 12.45) but in another format (HH:MM:SS, MM:SS, ISO8601 2018-01-18T12:31:40Z ...) you must use a converter that will convert the current format in seconds.

See the Converters' tab in the project configuration: [converters tab](#)

Click the **Start** button to start coding. The **Observation** window will be closed and you'll be transferred to the main **BORIS** window. If you do not want to start the observation click the **Save** button. The observation will be saved in the [observations list](#).

## Observations list

The **Observations > Observations list** will show you all the observations contained in the current BORIS project.

The observations can be sorted by clicking in the desired column header (alphabetic order ascending or descending).

Observations list - BORIS					
1440 observations					
	id	date	description	subjects	
1	0001	2016-05-17 00:00:31	Vegetation	Nautilus, Himal	#1: C:/Users/
2	0002	2016-05-17 00:00:24	Vegetation	Nautilus, Sharky, Himal	#1: C:/Users/
3	0003	2016-05-17 00:00:05	Vegetation	Nina, Nautilus, Sharky, Himal	#1: C:/Users/
4	0004	2016-05-17 00:00:59	Central trunks	Nina, Nautilus, Sharky, Himal	#1: C:/Users/
5	0005	2016-05-17 00:00:49	In the pool	Nautilus, Sharky	#1: C:/Users/
6	0006	2016-05-17 00:00:42	In the pool	Nautilus, Sharky, Himal	#1: C:/Users/
7	0007	2016-05-17 00:00:13	In the pool	Nina, Sharky, Himal	#1: C:/Users/
8	0008	2016-05-17 00:00:17	In the pool	Nautilus, Sharky, Himal	#1: C:/Users/
9	0009	2016-05-17 00:00:10	In the pool	Nina, Sharky, Himal	#1: C:/Users/
10	0010	2016-05-17 00:00:57	Area near the glass window	Nautilus, Sharky, Himal	#1: C:/Users/
11	0011	2016-05-17 00:00:50	Area near the glass window	Nina, Nautilus, Sharky, Himal	#1: C:/Users/
12	0012	2016-05-17 00:00:45	Area near the glass window	Nina, Sharky, Nautilus	#1: C:/Users/
13	0013	2016-05-17 00:00:25	Central trunks	Nina, Nautilus, Sharky, Himal	#1: C:/Users/
14	0014	2016-05-17 00:00:52	In the pool	Nina, Sharky, Nautilus, Himal	#1: C:/Users/
15	0015	2016-05-17 00:00:18	Central trunks	Nina, Nautilus, Sharky, Himal	#1: C:/Users/

The observations list can be filtered selecting a field and a condition in the drop-list boxes.

In the following example observations are filtered: only observations with **description** containing the **In the pool** subject are shown:

Observations list - BORIS				
93 observations				
	id	date	description	subjects
1	0005	2016-05-17 00:00:49	In the pool	Nautilus, Sharky
2	0006	2016-05-17 00:00:42	In the pool	Nautilus, Sharky, Himal
3	0007	2016-05-17 00:00:13	In the pool	Nina, Sharky, Himal
4	0008	2016-05-17 00:00:17	In the pool	Nautilus, Sharky, Himal
5	0009	2016-05-17 00:00:10	In the pool	Nina, Sharky, Himal
6	0014	2016-05-17 00:00:52	In the pool	Nina, Sharky, Nautilus, Himal
7	0185	2016-05-28 00:00:23	In the pool	Nina, Nautilus, Sharky
8	0212	2016-05-31 00:00:53	In the pool	Sharky
9	0217	2016-05-31 00:00:49	In the pool	Nina, Himal
10	0220	2016-05-31 00:00:36	In the pool	Nina, Nautilus, Sharky, Himal
11	0359	2016-06-06 00:00:54	In the pool	Nina, Sharky, Nautilus, Himal
12	0411	2016-06-07 00:00:53	In the pool	Nina, Nautilus
13	0412	2016-06-07 00:00:21	In the pool	Nautilus
14	0513	2016-06-10 00:00:48	In the pool	Nina, Sharky, Nautilus, Himal
15	0579	2016-06-13 00:00:32	In the pool	Nina, Nautilus, Sharky, Himal

Cancel      Open      Edit

Observations can be filtered with **Independent variables** values.

The following example displays only the observations that do not contain "Sunny" in the **Weather** independent variable :

Observations list - BORIS

148 observations

Weather does not contain Sunny

	id	date	description	subjects	cati	Weather	Temperature	Visitors
1	0197	2016-05-31 00:00:05	Latrine	Nina, Sharky, Nautilus, Himal	...	Cloudy	16.6	215
2	0198	2016-05-31 00:00:39	Latrine	Nina, Sharky	...	Cloudy	16.6	215
3	0199	2016-05-31 00:00:37	Latrine	Nautilus, Himal	...	Cloudy	16.6	215
4	0200	2016-05-31 00:00:45	Latrine	Nina, Nautilus, Sharky, Himal	...	Cloudy	16.6	215
5	0201	2016-05-31 00:00:48	Latrine...	Nina, Nautilus, Sharky, Himal	...	Cloudy	16.6	215
6	0202	2016-05-31 00:00:12	Latrine	Nina, Nautilus, Sharky, Himal	...	Cloudy	16.6	215
7	0203	2016-05-31 00:00:05	Central trunks	Nina, Nautilus, Himal	...	Cloudy	16.6	215
8	0204	2016-05-31 00:00:04	Central trunks	Nautilus, Himal	...	Cloudy	16.6	215
9	0205	2016-05-31 00:00:18	Central trunks	Himal	...	Cloudy	16.6	215
10	0206	2016-05-31 00:00:55	Central trunks	Nina, Nautilus, Sharky, Himal	...	Cloudy	16.6	215
11	0207	2016-05-31 00:00:55	Central trunks	Nina, Nautilus, Sharky, Himal	...	Rainy	16.6	215
12	0208	2016-05-31 00:00:58	Central trunks	Nina, Nautilus, Himal	...	Cloudy	16.6	215
13	0209	2016-05-31 00:00:00	Central trunks	Nina, Nautilus, Sharky, Himal	...	Cloudy	16.6	215
14	0210	2016-05-31 00:00:19	Central trunks	Nina, Sharky, Nautilus, Himal	...	Cloudy	16.6	215
15	0211	2016-05-31 00:00:56	Bank of the pool	Nina, Nautilus, Himal	...	Cloudy	16.6	215

Cancel Open Edit

Observations with a value of **Temperature** independent variable between 18 and 22:

Observations list - BORIS

780 observations

Temperature between (use and to separate terms) 18 and 22

	id	date	description	subjects	cati	Weather	Temperature	Visitors
1	0065	2016-05-26 00:00:48	Latrine	Nina	...	Sunny	20.1	1130
2	0066	2016-05-26 00:00:59	Latrine	Nina, Sharky	...	Sunny	20.1	1130
3	0067	2016-05-26 00:00:49	Latrine	Nautilus, Himal	...	Sunny	20.1	1130
4	0068	2016-05-26 00:00:54	Latrine	Nina, Nautilus	...	Sunny	20.1	1130
5	0069	2016-05-26 00:00:22	Latrine	Himal	...	Sunny	20.1	1130
6	0070	2016-05-26 00:00:42	Latrine	Nina, Nautilus, Sharky, Himal	...	Sunny	20.1	1130
7	0071	2016-05-26 00:00:49	Bank of the pool	Nina, Himal	...	Sunny	20.1	1130
8	0072	2016-05-26 00:00:12	Central trunks	Nina, Sharky	...	Sunny	20.1	1130
9	0073	2016-05-26 00:00:27	Central trunks	Sharky	...	Sunny	20.1	1130
10	0074	2016-05-26 00:00:02	Central trunks	Sharky	...	Sunny	20.1	1130
11	0075	2016-05-26 00:00:20	Central trunks	Nautilus, Himal	...	Sunny	20.1	1130
12	0076	2016-05-26 00:00:50	Central trunks	Nina, Nautilus, Sharky, Himal	...	Sunny	20.1	1130
13	0077	2016-05-26 00:00:05	Central trunks	Nina, Nautilus, Sharky, Himal	...	Sunny	20.1	1130
14	0078	2016-05-26 00:00:31	Central trunks	Nina, Nautilus, Sharky, Himal	...	Sunny	20.1	1130
15	0079	2016-05-26 00:00:15	Central trunks	Nina, Himal	...	Sunny	20.1	1130

Cancel Open Edit

Observations with a value of **Visitors** independent variable greater than 1000:

Observations list - BORIS									
824 observations									
Visitors	>	1000							
	id	date	description	subjects	... ati	Weather	Temperature	Visitors	
1	0001	2016-05-17 00:00:31	Vegetation	Nautilus, Himal	... 4...	Sunny	16.0	1046	
2	0002	2016-05-17 00:00:24	Vegetation	Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
3	0003	2016-05-17 00:00:05	Vegetation	Nina, Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
4	0004	2016-05-17 00:00:59	Central trunks	Nina, Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
5	0005	2016-05-17 00:00:49	In the pool	Nautilus, Sharky	... 4...	Sunny	16.0	1046	
6	0006	2016-05-17 00:00:42	In the pool	Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
7	0007	2016-05-17 00:00:13	In the pool	Nina, Sharky, Himal	... 4...	Sunny	16.0	1046	
8	0008	2016-05-17 00:00:17	In the pool	Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
9	0009	2016-05-17 00:00:10	In the pool	Nina, Sharky, Himal	... 4...	Sunny	16.0	1046	
10	0010	2016-05-17 00:00:57	Area near the glass ...	Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
11	0011	2016-05-17 00:00:50	Area near the glass ...	Nina, Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
12	0012	2016-05-17 00:00:45	Area near the glass ...	Nina, Sharky, Nautilus	... 4...	Sunny	16.0	1046	
13	0013	2016-05-17 00:00:25	Central trunks	Nina, Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	
14	0014	2016-05-17 00:00:52	In the pool	Nina, Sharky, Nautilus, Himal	... 4...	Sunny	16.0	1046	
15	0015	2016-05-17 00:00:18	Central trunks	Nina, Nautilus, Sharky, Himal	... 4...	Sunny	16.0	1046	

## Delete observations

The observations can be deleted from the project using the following procedure: **File > Edit project > Observation's tab**

Select all observations to remove

Click the **Remove selected observations** button and confirm the deletion.

Please note that the deletion is irreversible.

## Import observations from a project file

The **Observations > Import observations** option allows to import observations from a BORIS project file into the current project. Choose the project file and then the observations to import. BORIS will check if observations with same id are already existing in the current project. BORIS will also check if behaviors and/or subjects used in the imported observations are not defined in the current project.

## Coding your media

When looking at the BORIS main window, the window title bar shows the **Observation id - Project name - BORIS**. The media (the first in the queue) will be loaded in the media player and paused.

## Media controls are available in the toolbar



Key to the symbols:

- **Play**
- **Pause** (the SPACE bar can be used)
- **Rewind** reset your media at the beginning
- **Fast backward** jumps for n seconds backward in your media (See [general preferences](#) to set n)
- **Fast forward** jumps for n seconds forward in your media (See [general preferences](#) to set n)
- **Set the playback at speed 1x**
- **Increase playback speed** (See [general preferences](#) to set the step value)
- **Decrease playback speed** (See [general preferences](#) to set the step value)
- **Jump to the previous media file**
- **Jump to the next media file**
- **Take a snapshot** of current video or frame
- **Switch between VLC and frame-by-frame modes**

In frame-by-frame mode:

- **Move on frame back**
- **Move one frame forward**

The media can be controlled by special keyboard keys:

- **Page Up** key: switch to the next media
- **Page Down** key: switch to the previous media
- **Up arrow** key: jump forward in the current media
- **Down arrow** key: jump backward in the current media
- **ESC**: switch between VLC and frame-by-frame mode

## Ethogram widget in the main window

Key	Code	Type	Description	Modifiers
1   J	jump	Point event	jumping	foo,bar  foo,bar foo,...
2   G	groom	State event	Animal engages in washing or smoothing	self (s),others (o)
3   E	eat	State event	Animal consumes food	alone,in group orang...
4   O	look for food	State event	Animal searches the environment for food	
5   S	sleep	State event	Animal assumes position for sleep, stays in one place and is not alert...	light (l),deep (d)
6   D	dream	State event	Animal dreams	mvt (m),no mvt (n)
7   H	fight	State event	Animal engages a physical contact with another animal	
8   P	play	State event	Animal engages in interactions with others	alone (a),with others (o) b...
9   L	locomote	State event	Animal moves from place to place	

The **Ethogram** widget provide the user with the list of behaviors defined in the **Ethogram**. It can be used to record an event by double clicking on the corresponding row. The **Key** column indicates the keyboard key assigned to each behavior (if any). Pressing a key will record the corresponding behavior (that will appear in the *Events* widget).

## Subjects widget in the main window

Subjects			
Key	Name	Description	Current state(s)
1   1	Kanzi	Male, born October 28 - 1980	
2   2	Bongo	Male, adult	
3   3	Marco	Orangutan	

The **Subjects** widget provide the user with the list of subjects defined in the **Subject** tab in the **Project** window. It can be used to add information about the focal subject on the recorded behaviors by double clicking on the corresponding row. When a subject is selected his/her name appears above the media player. The **Key** column indicates the keyboard key assigned to each subject (if any).

## Media player widget in the main window



The **Media player** widget has two controls: the media position (horizontal slide bar) and the audio volume (vertical slide bar) provide the user with the list of subjects defined in the **Subject** tab in the **Project** window. The horizontal slide bar can be used to navigate the media file.

## Events widget in the main window

Events for observation #4					
	time	subject	code	type	modifier
1	00:00:16.040	Kanzi	eat	START	alone orange
2	00:00:30.320	Kanzi	eat	STOP	alone orange
3	00:00:44.240	Bongo	eat	START	in group banana
4	00:00:53.740	Bongo	eat	STOP	in group banana
5	00:01:11.480	Bongo	face		orb occ
6	00:01:21.920	Bongo	groom	START	self
7	00:01:31.240	Bongo	groom	STOP	self

The **Events** widget shows all the recorded behaviors with the following parameters (columns):

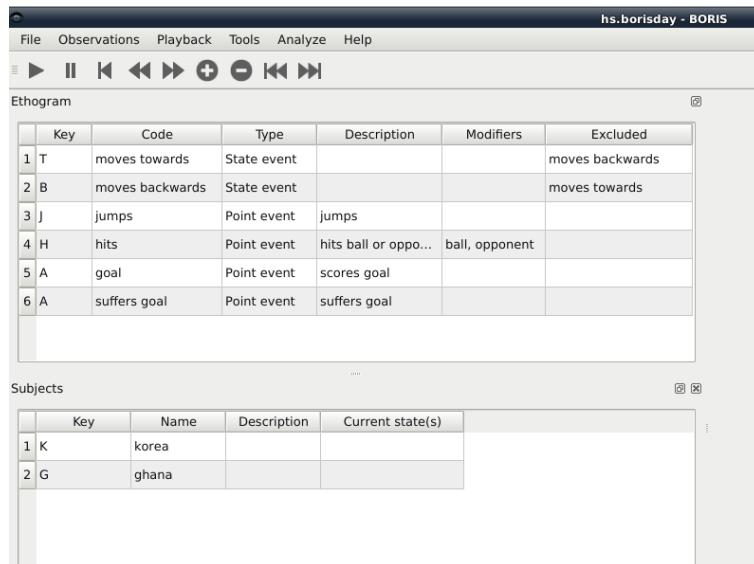
- **time**, the time at which the event occurred;
- **subject**, the focal subject (if any);
- **code**, the behavior code;
- **type**, in case of a state event indicates whether the time corresponds to the start or to the stop.
- **modifier**, indicates the modifier(s) that was(ere) selected (if any);
- **comment**, is an open field where the user can add notes.

A tracking cursor (red triangle) will show the current event. This cursor can be positioned above the current event, see [tracking cursor position](#) option in Preferences window.

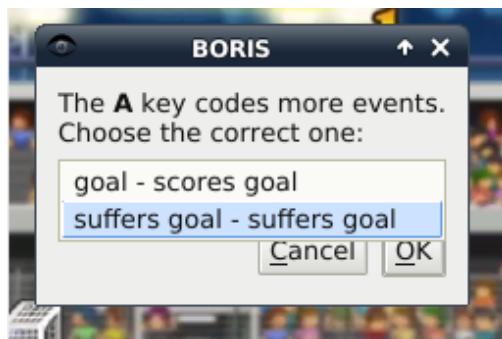
A double-click on a row will reposition the media player to the moment of the corresponding event. See [Time offset for media reposition](#) in Preferences window to customize the time offset for media repositioning.

## Record an event

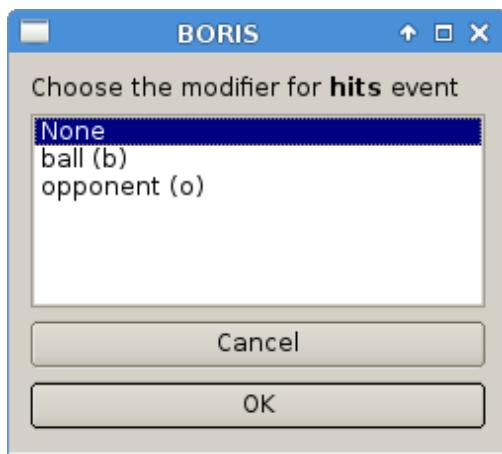
Once ready to begin your coding, you can start the media player using the **Play** button (or the Space bar). The behaviors can be recorded using the keyboard with the predefined keys, by double-clicking the corresponding row in the **Ethogram** table or by using the **Coding pad** (See [coding pad](#)).



If the pressed key defines a single event, the corresponding event will be recorded in the **Events** table. In the case you have specified the same key for two (or more) events (e.g. key A in the figure below), BORIS will prompt you for the desired behavior.



In the case you have specified modifiers (one or more sets), BORIS will prompt you for the desired modifier(s) if any (e.g. **ball** or **opponent** in the figure below). You can select the correct one using the mouse or the keyboard ( **b** key or **o** key)



In the case your behavior type is a *Point event with coding map* or a *State event with coding map*, BORIS will show the *Coding map* window and will allow selecting the desired area(s). In case you click a part of the map in which two (or more) areas overlap, the corresponding codes will be recorded.

A recorded event can be edited (once selected) using the *Observations > Edit event* menu option. The resulting *Edit event parameters* allows modifying every parameter (e.g. time, subject, code, modifiers, and comment).

The **Observations > Add event** menu option allows adding a new event by specifying its time and the other parameters.

## Frame-by-frame mode

You can switch between the media player and the frame-by-frame mode using the dedicated button in the toolbar:



In frame-by-frame mode the video will stop playing and the user will visualize the video frame by frame.

### **Warning**

Please note that MTS video files should be re-encoded to be used in frame-by-frame mode. Otherwise the extracted frames are not reliable.

You can move between frames by using the arrow keys in the toolbar (on the right) or by using keyboard special keys:

### **For the both modes (media player and frame-by-frame mode)**

- **Page Up** key: switch to the next media
- **Page Down** key: switch to the previous media
- **Up arrow** key: jump forward in the current media
- **Down arrow** key: jump backward in the current media
- **ESC**: switch between VLC and frame-by-frame mode

### **Only for the frame-by-frame mode**

- **Left arrow** key: go to the previous frame
- **Right arrow** key: go to the next frame

If you have a numeric keypad you can use the following keys in alternative:

- The key **/** will allow you to view the previous frame
- The key **\*** will allow you to view the next frame

To return in the media player mode press again the frame-by-frame button in the toolbar.

The frame can be resized before visualization. See the [frame resizing](#) option.

The frame viewer can be detached from the main window (See **File > Preferences**). In case on 2 simultaneous players the frame viewers will be automatically detached from the main window.

For every second of the media file the frames are extracted by BORIS with the embedded ffmpeg program and are saved in the [FFmpeg cache directory](#) specified in the [Preferences](#) window.

## Exporting events data

The coded events can be exported in various format (**Observations > Export ?**):

## Export events

This function will export the events of selected observations in TSV, XLS or ODS formats. These formats are suitable for further analysis.

A	B	C	D	E	F
1 Observation id	demo #1				
2					
3 Media file(s)					
4					
5 Player #1	/home/olivier/crop.avi				
6 Player #1	/home/olivier/crop2.avi				
7					
8 Observation date	2015-Nov-30 10:39:18				
9					
10 Description					
11					
12 Time offset (s)	0				
13					
14 independent variables					
15 variable	value				
16 group size	7				
17 weather conditions	rain				
18					
19 time	subject	code	Modifier	comment	status
20	4.3 Subject #1	eat	salad	test	START
21	10 Subject #1	eat	salad		STOP
22	26.6 Subject #2	eat	meat		START
23	113.988 Subject #2	eat	meat		STOP
24	116.588 Subject #1	jump			POINT
25	118.988 Subject #1	jump			POINT
26	120.863 Subject #2	jump			POINT
27	122.438 Subject #2	jump			POINT
28					

## Export aggregated events

This function will export the events of the selected observations in the following formats:

- **tabular format** (TSV, CSV, XLS, ODS, HTML)
- **SQL** format for populating a SQL database
- **SDIS** format for analysis with the GSEQ program available at <http://www2.gsu.edu/~psyrab/gseq>

The **State events** are paired and duration is available.

Example of tabular export

A	B	C	D	E	F	G	H	I	J
1 Observation id	Observation date	Subject	Behavior	Modifiers	Behavior type	Start	Stop	Comment start	Comment stop
2 demo #1	2015-Nov-30 10:39:18	Subject #1	jump		POINT	116.588	0		
3 demo #1	2015-Nov-30 10:39:18	Subject #1	jump		POINT	118.988	0		
4 demo #1	2015-Nov-30 10:39:18	Subject #1	eat	salad	STATE	4.3	10.0	test	
5 demo #1	2015-Nov-30 10:39:18	Subject #2	jump		POINT	120.863	0		
6 demo #1	2015-Nov-30 10:39:18	Subject #2	jump		POINT	122.438	0		
7 demo #1	2015-Nov-30 10:39:18	Subject #2	eat	meat	STATE	26.6	113.988		
8									
9									
10									

Example of SQL export:

```
CREATE TABLE events (id INTEGER PRIMARY KEY ASC, observation TEXT,
                     date DATE, subject TEXT, behavior TEXT,
                     modifiers TEXT, event_type TEXT, start FLOAT,
                     stop FLOAT, comment_start TEXT,
                     comment_stop TEXT);

INSERT INTO events (observation, date, subject, behavior, modifiers,
                    event_type, start, stop, comment_start, comment_stop) VALUES
('demo #1', '2015-11-30 10:39:18', 'Subj #1', 'jump', '', 'POINT', 116.588, 0, "", ""),
('demo #1', '2015-11-30 10:39:18', 'Subj #1', 'jump', '', 'POINT', 118.988, 0, "", ""),
('demo #1', '2015-11-30 10:39:18', 'Subj #1', 'eat', 'salad', 'STATE', 4.3, 10.0, 'vvv', ""),
('demo #1', '2015-11-30 10:39:18', 'Subj #2', 'jump', '', 'POINT', 120.863, 0, "", ""),
('demo #1', '2015-11-30 10:39:18', 'Subj #2', 'jump', '', 'POINT', 122.438, 0, "", ""),
('demo #1', '2015-11-30 10:39:18', 'Subj #2', 'eat', 'meat', 'STATE', 26.6, 113.988, "", "");
```

## Export events as behavioral strings

Behavioral string can be used with the BSA service: Behavioral Strings Analysis (BSA)

Example:

```
# observation id: demo#1
# observation description:
# Media file name: crop.avi, crop2.avi

Subject #1:
eat|eat|jump|jump

Subject #2:
eat|eat|jump|jump
```

## Export events as Praat TextGrid

Example:

```
File type = "ooTextFile"
Object class = "TextGrid"

xmin = 4.3
xmax = 113.988
tiers? <exists>
size = 2
item []:
    item [1]:
        class = "IntervalTier"
        name = "Subject #1"
        xmin = 4.3
        xmax = 10.0
        intervals: size = 1
        intervals [1]:
            xmin = 4.3
            xmax = 10.0
            text = "eat"
    item [2]:
        class = "IntervalTier"
        name = "Subject #2"
        xmin = 26.6
        xmax = 113.988
        intervals: size = 1
        intervals [1]:
            xmin = 26.6
            xmax = 113.988
            text = "eat"
```

## Extract sequences from media files

Sequences of media file corresponding to coded events can be extracted from media files:

1. Click on **Observations > Extract events from media files** option.
2. Choose the observation(s).

3. Select the events to be extracted.
4. Select a destination directory that will contain the extracted sequences.
5. Select a time offset (in seconds, the default value is 0).

The time offset will be subtracted from the starting time of event and added to the stopping time. All the extracted sequences will be saved in the selected directory followind the file name format:

{observation id}\_{player}\_{subject}\_{behavior}\_{start time}-{stop time}

## Export transitions matrix

3 transitions matrix outputs are available: The matrix of frequencies of transitions, the matrix of frequencies of transition after each behavior and the matrix of number of transitions.

### ***Matrix of frequencies of transitions***

This matrix contains the frequencies of total transitions. The sum of all frequencies must be 1.

Example of frequencies of transitions matrix:

	eat	sleep	walk
eat	0.0	0.286	0.143
sleep	0.143	0.0	0.143
walk	0.286	0.0	0.0

In this matrix you can see that the **eat** behavior precedes the **sleep** behavior with a frequency of **0.286** of the total number of transitions.

### ***Matrix of frequencies of transitions after behavior***

This matrix contains the frequencies of transitions after each behavior. The sum of each row must be 1.

Example:

	eat	sleep	walk
eat	0.0	0.667	0.333
sleep	0.5	0.0	0.5
walk	1.0	0.0	0.0

In this example you can see that **sleep** follows **eat** with a frequency of **0.667** and **walk** follows with a frequency of **0.333**.

### ***Matrix of number of transitions***

This matrix contains the number of transitions after each behavior.

Example:

	eat	sleep	walk
eat	0	2	1
sleep	1	0	1
walk	2	0	0

## Playback menu

### Jump

#### ***Jump forward***

Allow to jump forward in the current media file. See **File > Preferences** for setting the jump value.

#### ***Jump backward***

Allow to jump backward in the current media file. See **File > Preferences** for setting the jump value.

#### ***Jump to specific time***

Allow to go to a specific time in the current media file.

### Zoom

Allow to zoom into the current video file. The available zoom values are: 1:2, 1:4, 2:1 and 1:1. **Fit to window** adapts the zoom value to the current window size. In case of simultaneous playing you can set different values of zoom in player #1 and player #2.

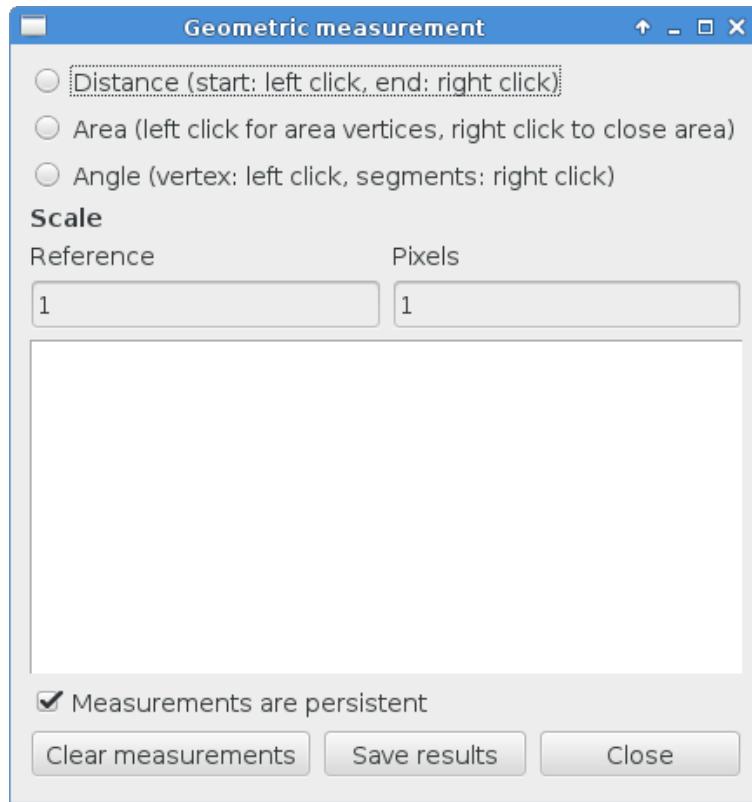
The Zoom option is not available in frame-by-frame mode.

#### **The Zoom function is not working on Mac**

## Tools

### Geometric measurements

Geometric measurements can only be made in frame-by-frame mode. Distances, areas and angles can be measured. Click on **Tools > Geometric measurements** to activate the measurements. The **Measurements window** will be shown:

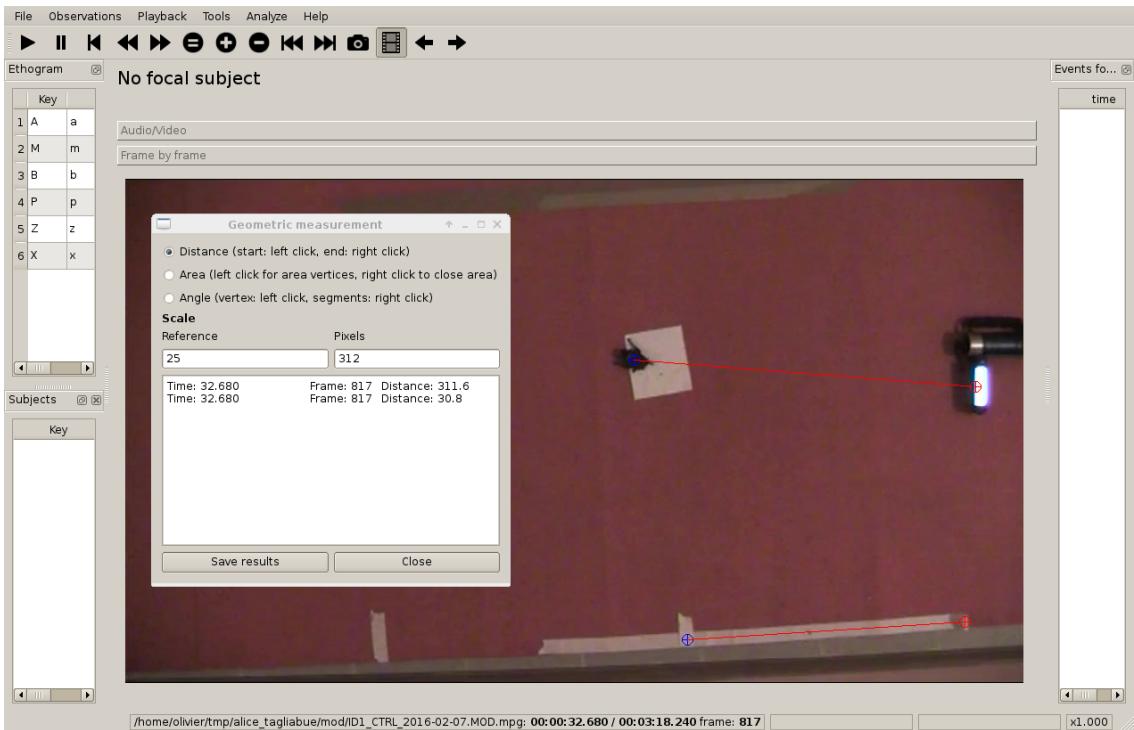


## **Setting the scale**

For distance and area measurements you can set a scale in order to have results of measurements in a real unit (like centimeters, meters etc). 1) measure a reference object (that have a known size) on the frame (with the distance tool. See next chapter for details) and set the pixel distance in the **Pixel** text box. 2) Set the real size of the reference object in the **Reference** text box (must be a number without unit).

## **Distance measurements**

Select the **Distance** radio button. Click the left mouse button on the frame bitmap to set the start of the segment that will be measured. A blue circle with a cross will be drawn. Click the right mouse button to set the end. A red circle with a cross will be drawn. The distance between the two selected points will be available in the text area of the **Measurements window**.



## Area measurements

Select the **Area** radio button. Click the left mouse button on the frame bitmap to set the area vertices. Blue circles with a cross will be drawn. Click the right mouse button to close the area. The area of the drawn polygon will be available in the text area of the **Measurements window**.

## Angle measurements

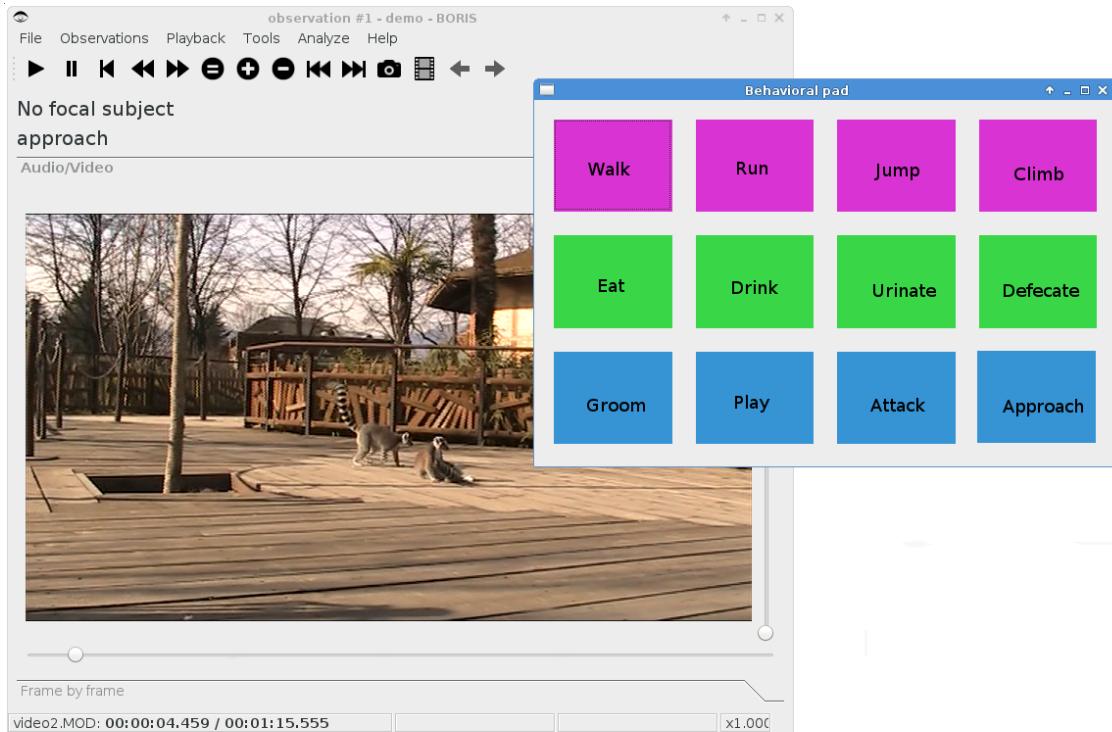
Select the **Angle** radio button. Click the left mouse button on the frame bitmap to set the angle vertex. A red circle with a cross will be drawn. Click the right mouse button to set the two segments. Blue circles with a cross will be drawn. The angle between the two drawn segments will be available in the text area of the **Measurements window**.

## Persistent measurements

If the **Measurements are persistent** checkbox is checked the measurement schemes will be available on all frames otherwise they will be deleted between frames.

## Coding pad

During observation a coding pad with the available behaviors can be displayed (**Tools > Coding pad**). This **Coding pad** allows the user to code using a touch-screen or by clicking on the buttons. When the **Coding pad** is displayed you can continue to code using the keyboard or the ethogram.



## Transitions flow diagram

BORIS can generate DOT scripts and flow diagrams from the transitions matrices (See Observations > Create transition matrix for obtaining the transitions matrices).

### ***DOT script (Graphviz language)***

#### **Tools > Transitions flow diagram > Create transitions DOT script**

Choose one ore more transitions matrix files and BORIS will create the relative DOT script file(s).

The DOT script files can then be used with [Graphviz](#) (Graph Visualization Software) or [WebGraphviz](#) (Graphviz in the Browser) to generate flow diagram of transitions.

See [DOT \(graph description language\)](#) for details.

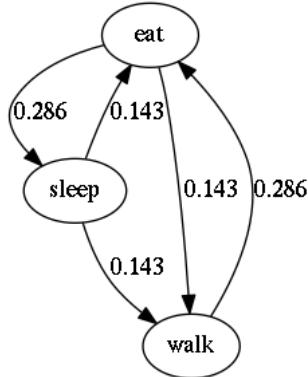
### ***Flow diagram***

If [Graphviz](#) (Graph Visualization Software) is installed on your system (and the **dot** program available in the path) BORIS can generate flow diagram (PNG format) from a transitions matrix file.

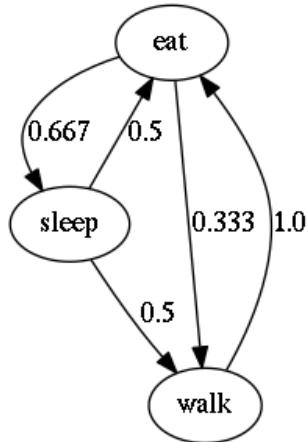
#### **Tools > Transitions flow diagram > Create transitions flow diagram**

Choose one ore more transition matrix files and BORIS will create the relative flow diagram.

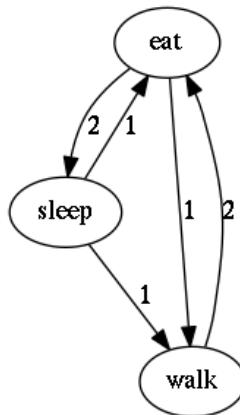
### **Flow diagram of frequencies of transitions**



### **Flow diagram of frequencies of transitions after behavior**



### **Flow diagram of number of transitions**



## **Re-encoding and resizing a video file**

BORIS can re-encode and resize your video files in order to reduce the size of the files and have a smooth coding (specially with two video files playing together). The re-encoding and resizing operations are done with the embedded ffmpeg program with high quality parameters (bitrate 2000k).

Select the files you want re-encode and resize and select the horizontal resolution in pixels (the default is 1024). The aspect ratio will be maintained.

You can continue to use BORIS during the re-encoding/resizing operation.

The re-encoded/resized video files are renamed by adding the re-encoded.avi extension to the original files.

#### **warning**

**The MTS video files should be re-encoded to be used in frame-by-frame mode. Otherwise the extracted frames are not reliable.**

## **Project server**

This function allow you to communicate with the **BORIS App** by sending project and receiving observations made with the **BORIS App**. For details read the **BORIS App user guide**

### ***Starting the project server***

- Open your project
- Select **File > Project server**

A window will open and show you the URL of the server that should be used on the **BORIS App**. The project server will serve the project for 30 minutes.

### ***Stopping the project server***

- Select **File > Stop serving project**

## **Coding map**

A coding map is a bitmap image with user-defined clickable areas that will help to code for behaviors or modifiers for a behavior.

2 types of coding maps are available:

- Behaviors coding map
- Modifiers coding map

## **The Behaviors coding map**

BORIS allows creating a **Behaviors coding map** using the **Map creator** tool (**Tools > Create a coding map > for behaviors**).

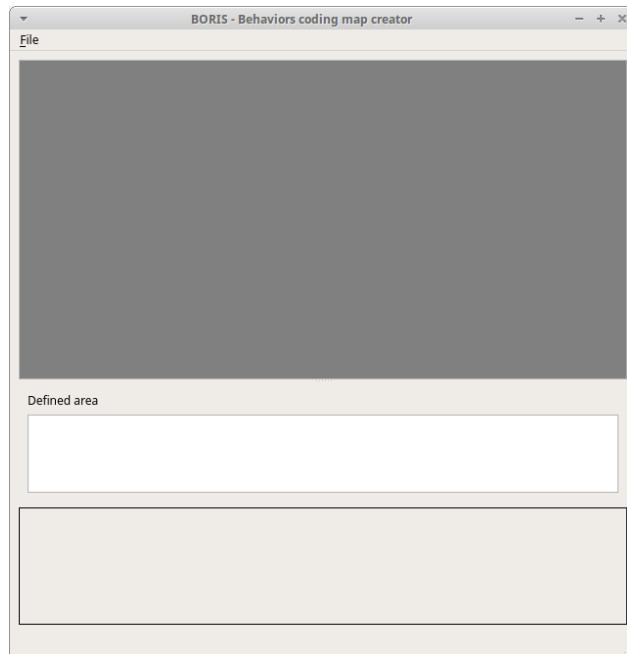
A **Behaviors coding map** can be created only if you have defined behaviors in your ethogram.

### ***Creating a Behaviors coding map***

To create a new **Behaviors coding map** launch the **Behaviors coding map creator**

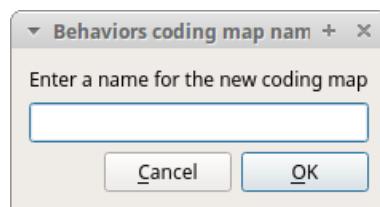
**Tools > Create a coding map > for behaviors**).

A new window will open



**File > New behaviors coding map**

Enter a name for the new **Behaviors coding map**

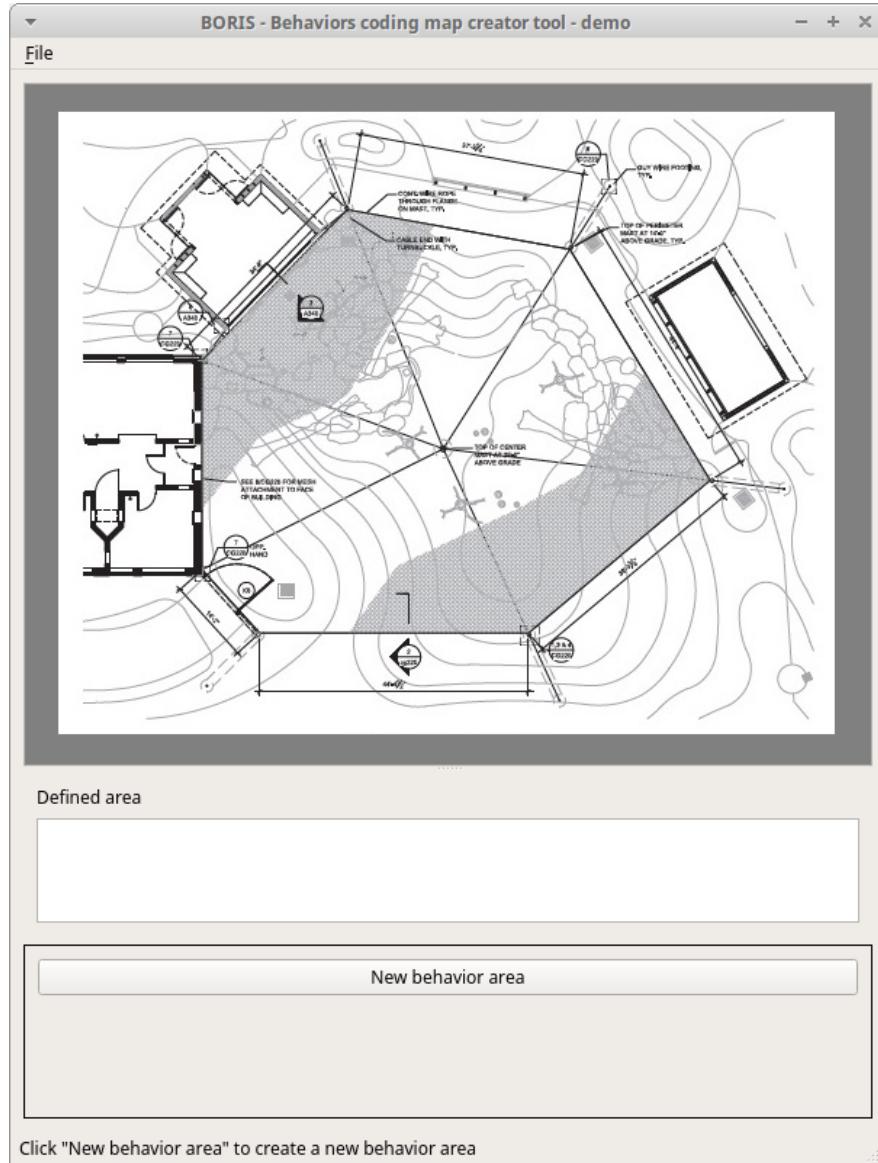


***Loading a bitmap for a behaviors coding map***

Click the **Load bitmap** button in the bottom of the window and select a bitmap image (PNG and JPEG formats are accepted).

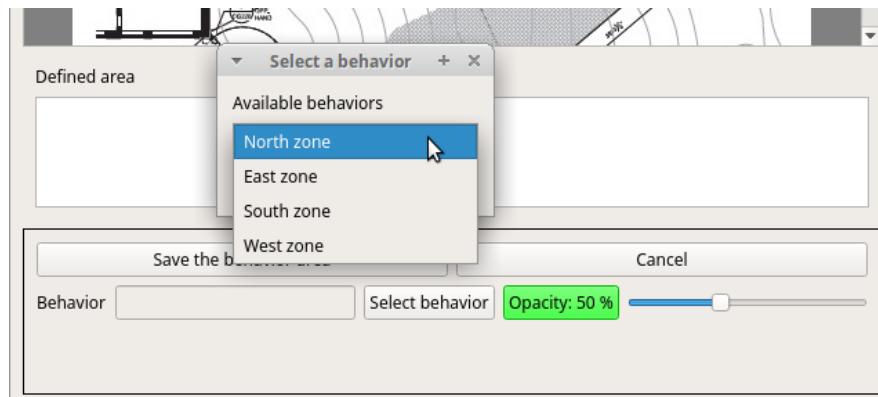
If the size of your bitmap image is bigger than 640 x 640 pixels BORIS will resize it to 640 x 640 pixels keeping the aspect ratio and store the resized version in the coding map file.

The bitmap will be displayed



### **Adding areas corresponding the behaviors**

Click the **New behavior area** button in the bottom of the window and select a behavior by clicking on the **Select behavior** button.



The available behaviors are taken from the ethogram of the current project.

Click on the bitmap to define the vertex on the area that will code the selected behavior. Close the area by clicking again on the first point.

The color of the new area can be changed using the **Opacity** button. The opacity can be changed (from 0 to 100%) using the slider.

Save the behavior area by clicking on the **Save the behavior area** button

The area will be added to the **Defined area** list

You can add more area and also add more than one area for a same behavior. Two or more areas can overlap. In this case all corresponding behaviors will be triggered.



#### ***Add the Behaviors coding map to the current project***

**File > Add coding map to project**

The coding map will be added to the current project

You can add a **Behaviors coding map** to the current project from a file containing the coding map:

(**File > Edit project > Behaviors coding map > Add a behaviors coding map** )

#### ***Saving the Behaviors coding map***

Saving the **Behaviors coding map** will create a file containing the **Behaviors coding map** including the bitmap image.

**File > Save the current Behaviors coding map**

The file containing the **Behaviors coding map** can be then reloaded in the **Behaviors coding map creator** or added to a BORIS project (**File > Edit project > Behaviors coding map > Add a behaviors coding map** )

## The Modifiers coding map

BORIS allows creating a modifiers coding map using the **Modifiers Map creator** tool (**Tools > Create a coding map > for modifiers**.) Clickable areas may correspond to specific modifiers that can be meaningful for the behavioral coding. Facial expression is the case we thought to when developing this function.

### **Creating a modifiers coding map**

#### **Loading a bitmap for a modifiers coding map**

To create a new **Modifiers coding map**, launch the **Modifiers Map creator** tool (**Tools > Create a coding map > for modifiers**). The BORIS main window will be replaced by the **Modifiers Map creator** window. Click on **Modifiers Map creator > New Modifiers map** and enter a name for the new map in the edit box. You have to load a bitmap image (JPEG or PNG) using the **Load bitmap** button. The loaded image will be displayed.



If the size of your bitmap image is bigger than 640 x 640 pixels BORIS will resize it to 640 x 640 pixels keeping the aspect ratio and store the resized version in the coding map file.

### **Adding areas corresponding to the modifiers**

To create clickable areas on a coding map, you have to click on the **New area** button and enter an **Area code** in the edit box. The new area can now be defined by clicking on the image. The drawing tool allows defining a irregular polygon (a plane shape with straight sides, which does not have all sides equal and all angles equal) by clicking to determine subsequent vertices. It can be convex or concave. Straight sides must not cross each other. Once selected an area can be deleted using the **Delete area** button. When an area is closed and its name has been defined in the **Area code** field, it can be saved by using the **Save area** button. The areas can partially overlap each other. See the **Using a Coding map** section for more details. Once all areas are added the entire map can be saved using the **Save map** option menu (**Map creator > Save map**). The map is now saved in its own file (.boris\_map) which is NOT part of the BORIS project. A map can be edited at anytime by opening the map file from the **Open map** menu option (**Map creator > Open map**).

### **Adding a modifiers coding map to your project**

Creating a Coding map is not automatically adding the map to your project. The Coding map have to be added to your project by selecting the corresponding **Behavior type (Point event with coding map, State event with coding map)**. BORIS will ask to select the file name containing the coding map (.boris\_map) and load the coding map in the project. The coding map name will appear in the **Coding map** column and will be saved in the BORIS project file.

NOTE: If you later modify your coding map you must reload the new version in your BORIS project.

## **Analysis**

### **Time budget**

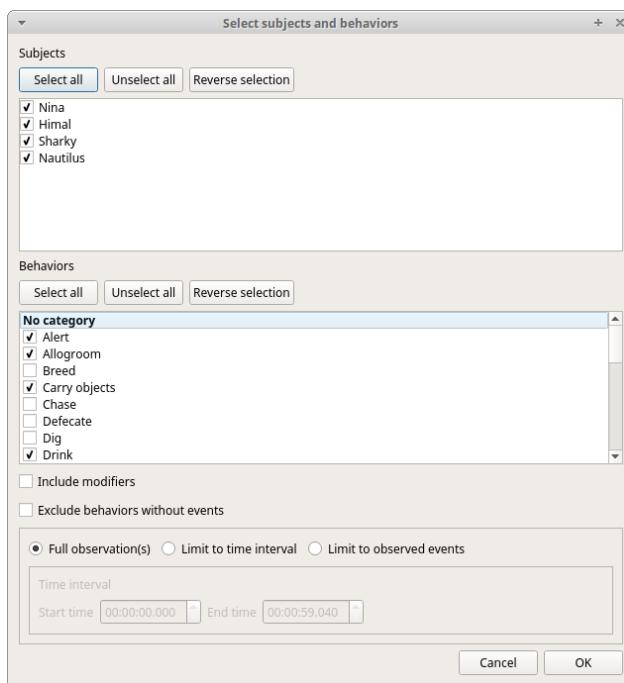
The **Time budget** analysis can be done by behavior or by category of behaviors. Choose the option from the **Analysis** menu.

The **Time budget** analysis can be done on one or more observations. If you select more than one observation you must then choose for a global time budget analysis that will contain all selected observations or a time budget analysis for every single observation.



Choose **Yes** to group all observations in on time budget analysis

The **Analysis > Time budget** menu option shows the time budget for the events of the selected observations. Select the subjects and behaviors you want to include in the time budget analysis:



All behaviors can be selected or unselected by clicking on the Category (bold).

You can choose to include or not the behavior modifiers in the Time budget analysis and to exclude behaviors without coded events.

The Time budget analysis can be restricted to a part of the observation:

- Full observation(s): the analysis will be made on the full observation length.
- Limit to time interval: use the **Start time** and **End time** boxes to select starting time and ending time.
- Limit to observed events: the analysis will be made from the first observed event to the last observed event.

The results contain for each subject and behavior the **total number of occurrences**, the **total duration** (for the behaviors defined as state events), The **duration mean** (for the behaviors defined as state events), the **standard deviation of duration**, the **inter-events intervals duration mean**, the **standard deviation of the inter-events intervals duration** and the **percent of total duration of observation(s)**. All duration times are expressed in seconds (s).

Time budget

Selected observations

	Subject	Behavior	Modifiers	Total number	Total duration (s)	Duration mean (s)	Duration std dev	inter-event intervals mean (s)	inter-event intervals std dev	% of total length
1	Nina	Alert	-	1	1.882	1.882	NA	NA	NA	0.4
2	Nina	Locomotion	-	2	2.913	1.457	0.824	NA	NA	0.7
3	Nina	Manipulate	-	2	65.048	32.524	15.414	NA	NA	14.6
4	Nina	Rest	-	1	25.549	25.549	NA	NA	NA	5.7
5	Himal	Alert	-	4	18.131	4.533	2.542	10.95	NA	4.1
6	Himal	Allogroom	-	1	3.603	3.603	NA	NA	NA	0.8
7	Himal	Drink	-	1	1.133	1.133	NA	NA	NA	0.3
8	Himal	Locomotion	-	10	36.633	3.663	5.777	6.124	5.88	8.2
9	Himal	Manipulate	-	3	66.702	22.234	17.18	4.723	NA	15.0
10	Himal	Play on the ground	-	1	16.46	16.46	NA	NA	NA	3.7
11	Himal	Rub	-	1	11.031	11.031	NA	NA	NA	2.5
12	Himal	Self-groom	-	1	3.571	3.571	NA	NA	NA	0.8

Total observation length: 00:07:25.680

The time budget results can be saved in various formats for further analysis:

- \* Plain text files: TSV, CSV or HTML
- \* Spreadsheets: Open Document (ODS), Microsoft Excel (XLSX) and Legacy Microsoft (XLS)

### Note

If a STATE behavior has an odd number of coded events, BORIS will report "UNPAIRED" instead of results"

## Synthetic time budget

The synthetic time budget is similar to time budget but with fewer parameters and a different organization of results. Results of all selected observations are organized in columns on a single page. Two parameters are provided for now: **number of occurrences** and **total duration** (for the behaviors defined as state events)

	A	B	C	D	E	F	G	H	I	J	
1			Nina Alert	Nina Alert	Nina Allogroom	Nina Allogroom	Nina Breed	Nina Breed	Nina Carry objects	Nina Carry objects	Nina Chas
2			Total length (s)	Total duration	Number of occurrences	Total duration	Number of occurrent	Total duration	Number of occ	Total duration	Number of occ
40	0037	32.160									
41	0038	86.880	1.675	1							
42	0039	96.960	13.471	2							
43	0040	335.520	86.615	12	15.84	2					
44	0041	130.560	9.069	2	5.85	1					
45	0042	36.960	24.298	3							
46	0043	107.040	42.928	5							
47	0044	109.920	11.769	4	12.471	2					
48	0045	102.240	72.857	6							
49	0046	84.960	44.459	6							
50	0047	77.280	68.929	2							
51	0048	23.520	3.1	1	10.797	1					
52	0049	34.080	9.897	2	8.431	1					
53	0050	23.040									
54	0051	44.160	1.079	1							
55	0052	18.240									
56	0053	39.840									
57	0054	35.040									
58	0055	256.800	61.321	15	19.73	1					
59	0056	26.400	15.241	5							
60	0057	45.120	6.887	3	10.984	2					
61	0058	45.120	2.647	1							
62	0059	41.760									
63	0060	292.800	1.543	2							
64	0061	25.920									

All duration times are expressed in seconds (s).

The time budget results can be saved in various formats for further analysis: \* Plain text files: TSV, CSV or HTML \* Spreadsheets: Open Document (ODS), Microsoft Excel (XLSX) and Legacy Microsoft (XLS)

## Plot events

The events from a selected observation can be plotted along a time axis. Two types of plot are available.

### ***Plot events (Back compatibility)***

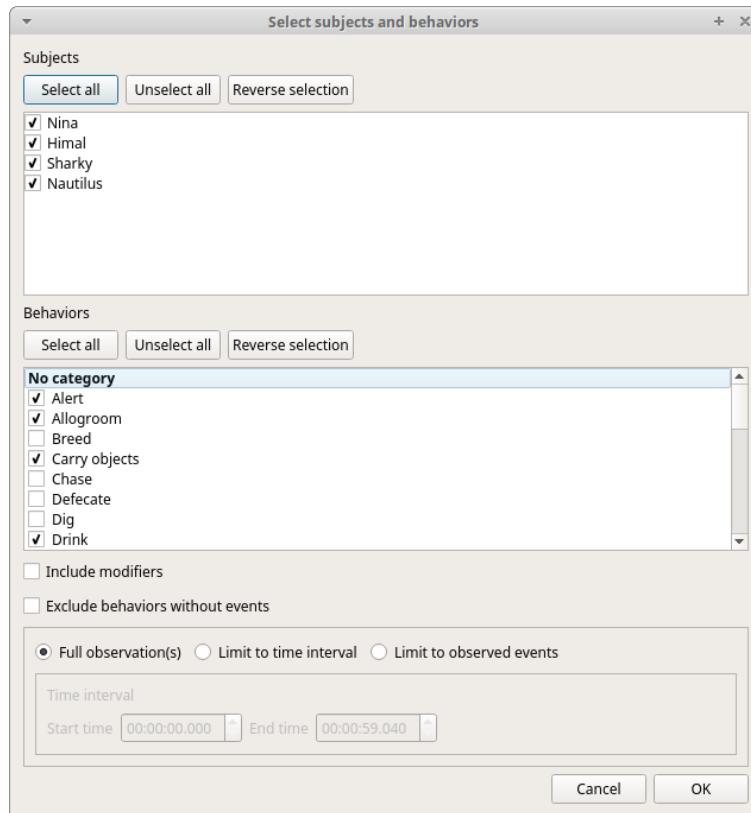
#### **Note**

This function is now deprecated and may contain bugs. See [plot events v.2](#)

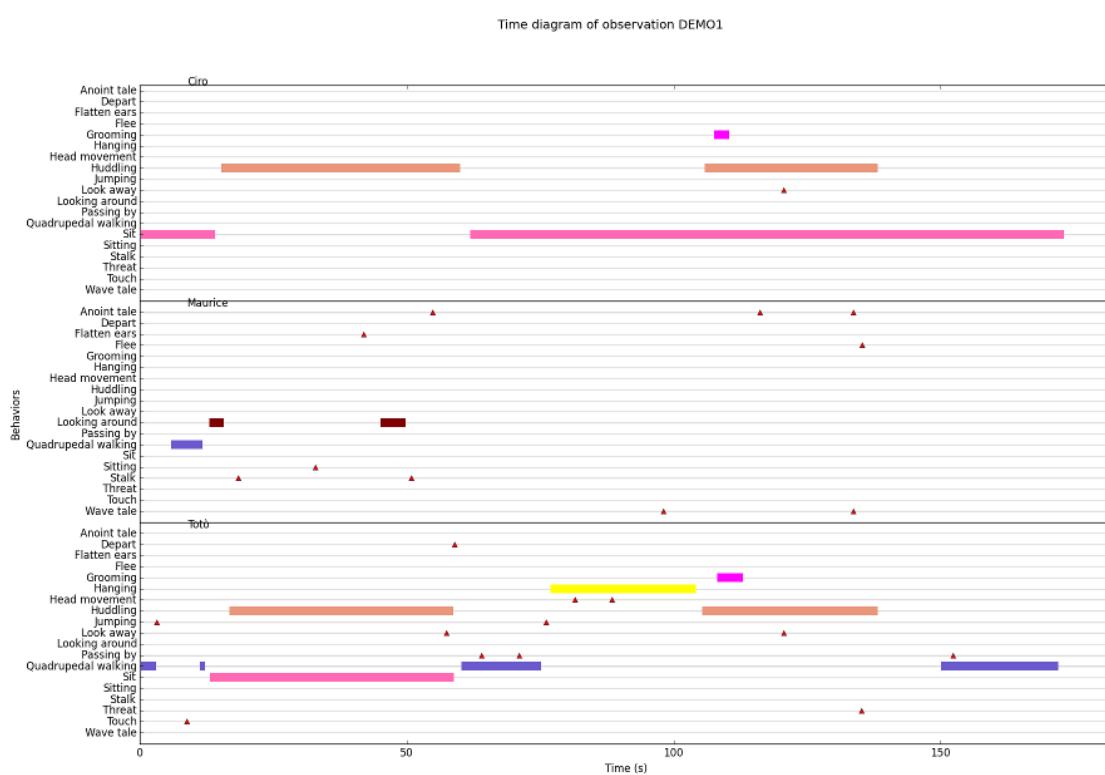
### **Analysis > Plot events (Back compatibility)**

The function allows to plot only one observation.

The subjects and behaviors you want to include in the plot can be selected:



You can choose to include or not the behavior modifiers (if any) and to exclude behaviors without coded events.



The color of behaviors can be customized. See [plot colors](#)

The plot can be exported in various formats like bitmap (PNG, JPG, TIFF) or vectorial graphic (SVG, PDF, EPS, PS). The SVG format can be further edited with the [Inkscape vector graphics editor](#).

### Note

If a STATE behavior has an odd number of coded events, you will see this error message: "The STATE behavior XXX is not paired"

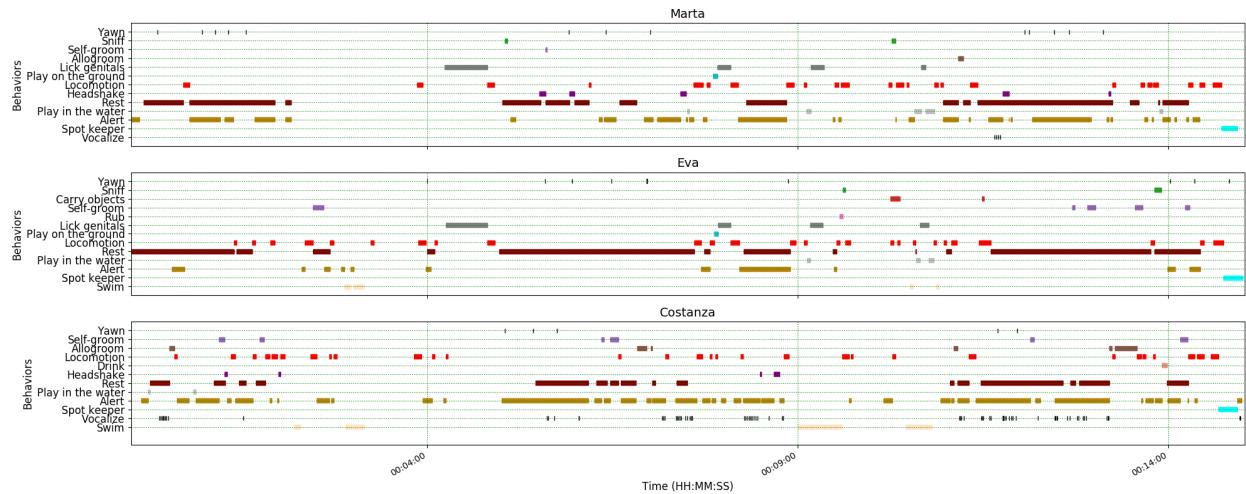
## Plot events

### Analysis > Plot events

With this function you can select many observations to be plotted. This function creates one plot by subject on one figure.

The time interval can be selected (See time budget)

The color of behaviors can be customized. See [plot colors](#)

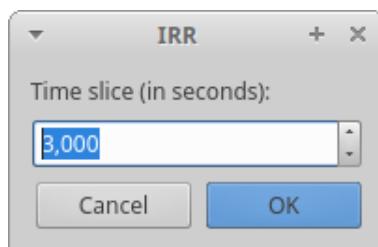


## Inter-rater reliability

The Cohen's kappa coefficient can be calculated ([Analysis > Inter-rater reliability > Cohen's kappa](#)).

[Cohen's kappa on Wikipedia](#)

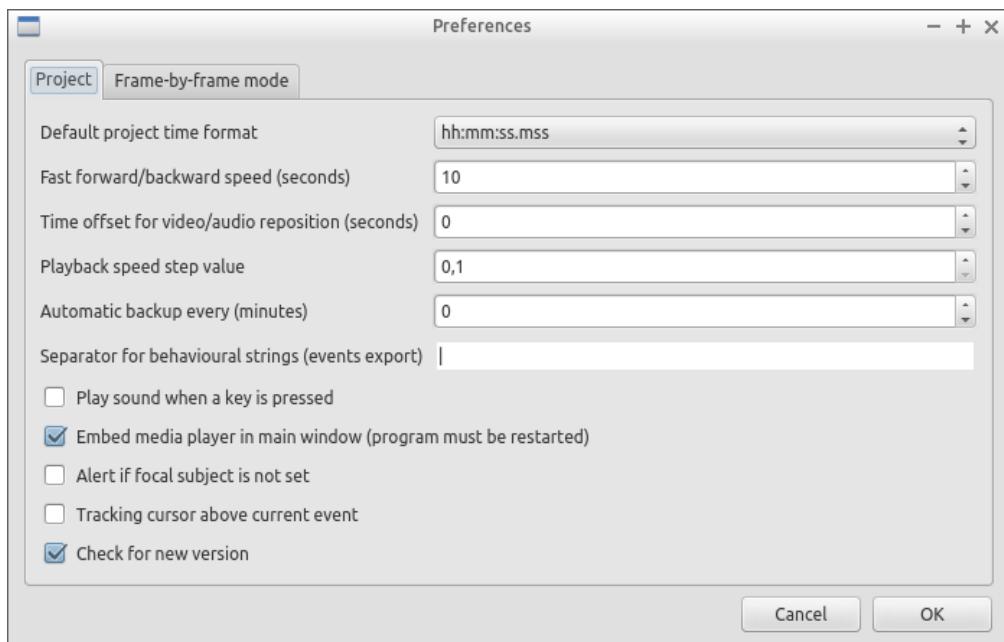
After selecting 2 observations and a time window (in seconds) for the analysis (the default value is 10 seconds) the Cohen's kappa will be displayed in the results window.



## Preferences

You can customize BORIS using the Preferences window ([File > Preferences](#))

## General preferences



### Default project time format

This option allows the user to choose the format for displaying time in the project. Please note that time is internally always saved in seconds with a precision of 3 decimal digits

### Fast forward/backward speed (seconds)

This option allows the user to customize the amount of time for "jumping" forward or backward in media.

### Time offset for media reposition (seconds)

This value indicates the time offset for repositioning the media after double-click on a row event of the Events table. 'for example -4 seconds indicates that after a double-click the media will be repositioned 4 seconds before the recorded event.'

### Playback speed step value

This value indicate how much the speed will be increased or decreased after pressing the *change playback speed* buttons.

### Automatic backup every (minutes)

If set BORIS will save your project automatically every n minutes. 0 indicate no automatic backup.

### Play sound when a key is pressed

Activate a sound signal after every keypress event

### Embed media player

This option allows the user to detach from the main window or embed the media player in the main window. **On Mac OS the media player can not be detached from main window.**

### Alert if focal subject is not set

If this option is activated BORIS will show an alert box if no focal subject is selected

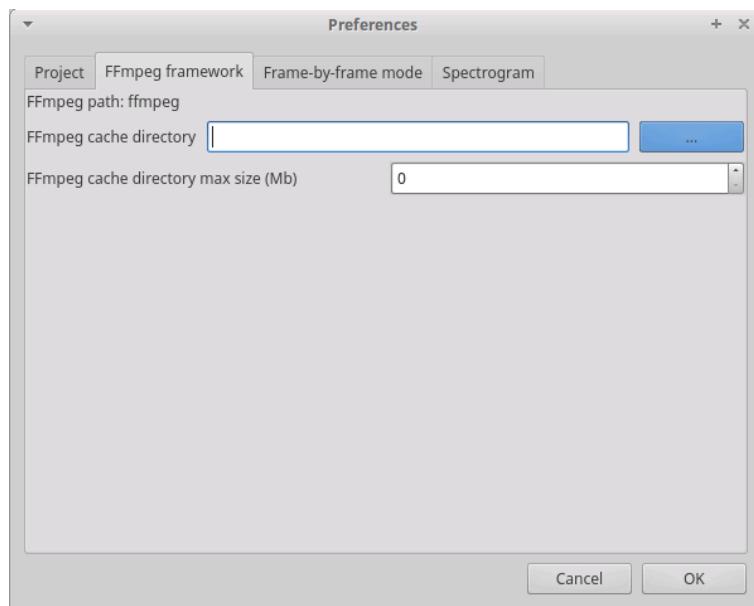
### Tracking cursor above current event

Check this box to position the tracking cursor above the current event in events list table.

### Check for new version

Check for new version on BORIS web site every 15 days (internet access required)

## FFmpeg framework



The path for the ffmpeg executable program is displayed. The FFmpeg executable is now included with BORIS in Windows and Mac OS versions.

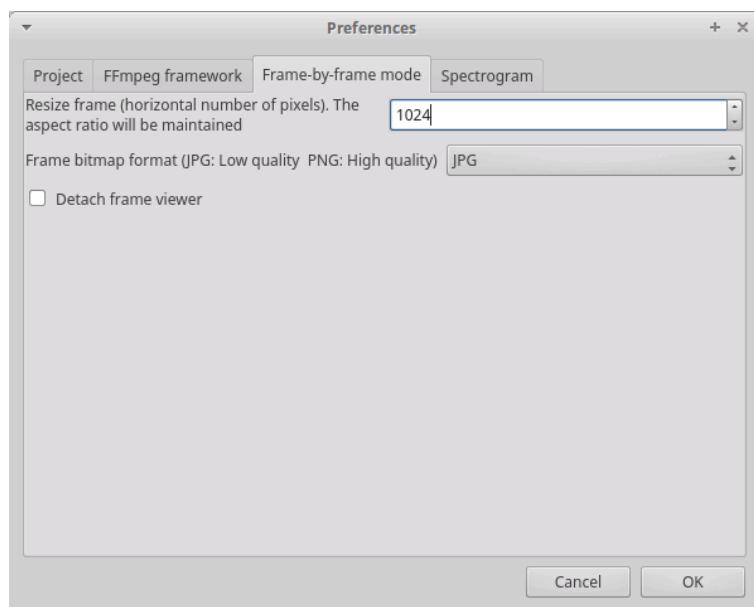
### FFmpeg cache directory

This indicates the directory that will be used as image cache for frame-by-frame mode and spectrogram visualization. If you do not specify a path, BORIS will use the default temporary directory of your system.

### FFmpeg cache directory max size

Indicate a size limit (in Mb) for the image caching. 0 indicates no limit

## Frame-by-frame mode



## **Resize frame**

In case of high resolution video (for example 4K 1920x1080) the extracted frames can be resized before visualization to improve the speed. Select the width in pixel for the extracted frames. The aspect ratio will be maintained. 0 will indicate no frame resizing.

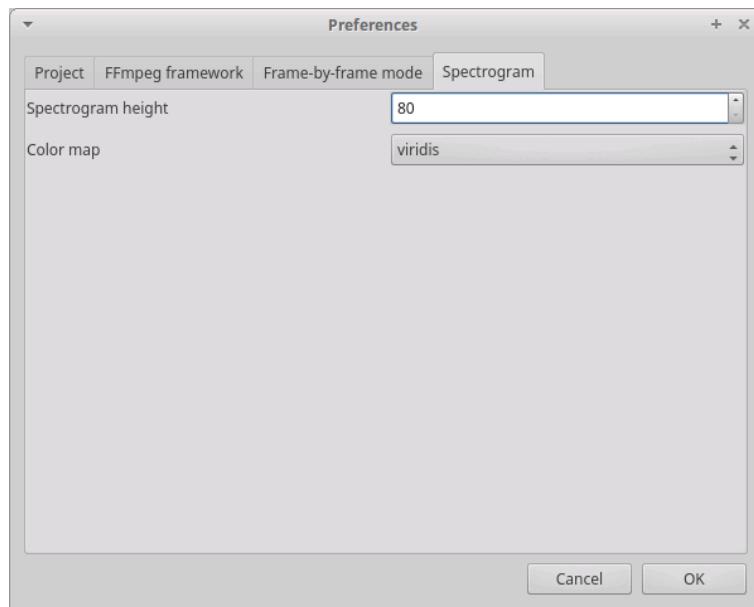
## **Frame bitmap format**

A bitmap format can be selected between JPG (JPEG low quality image) and PNG (Portable Network Graphic - high quality image). The extracted frames will be saved in the directory defined in previous tab (FFmpeg cache directory).

## **Detaching the frame viewer**

The frame viewer can be detached from the main window. Please note that in case of two simultaneous media files the frames viewers will be detached.

# **Spectrogram**



## **Spectrogram height**

Select the height of generated spectrogram (in pixels). You will need to restart the current observation to apply changes.

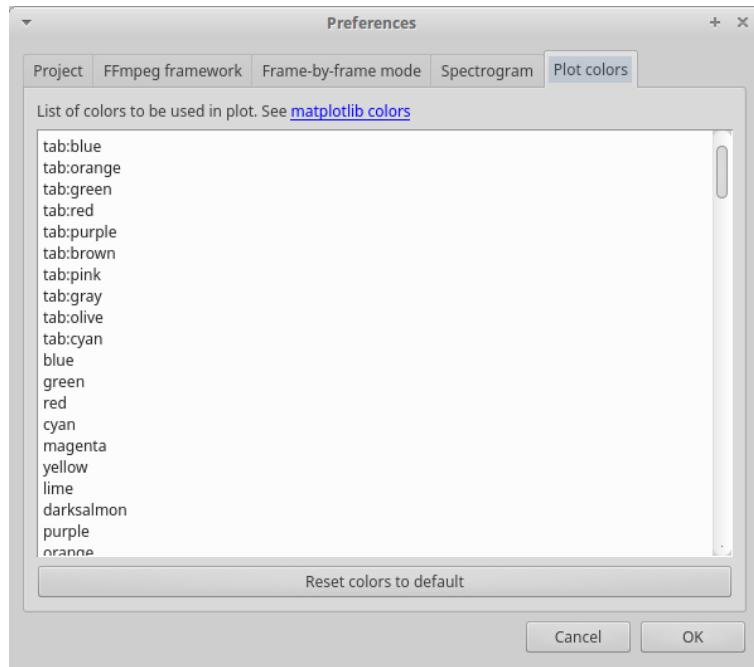
## **Color map**

Select the color map for displaying the generated spectrogram. See [Matplotlib colormaps](#) for details.

# **Plot colors**

The color of behaviors in the plot events functions can be customized. The first color will be associated to the first behavior in your ethogram, the second color to the second behavior and so on. Various color formats can be used to specify a color: **named color** or **hex RGB** (like #0F0F0F). See [https://matplotlib.org/api/colors\\_api.html](https://matplotlib.org/api/colors_api.html) and [https://matplotlib.org/examples/color/named\\_colors.html](https://matplotlib.org/examples/color/named_colors.html) for details

The **reset colors to default** button will reload the default colors.



## Various

### Citing BORIS

If you have used BORIS for publications, please cite:

Olivier Friard and Marco Gamba. (2016) BORIS: a free, versatile open-source event-logging software for video/audio coding and live observations. *Methods in Ecology and Evolution*, 7(11), 1324-1330  
DOI: 10.1111/2041-210X.12584

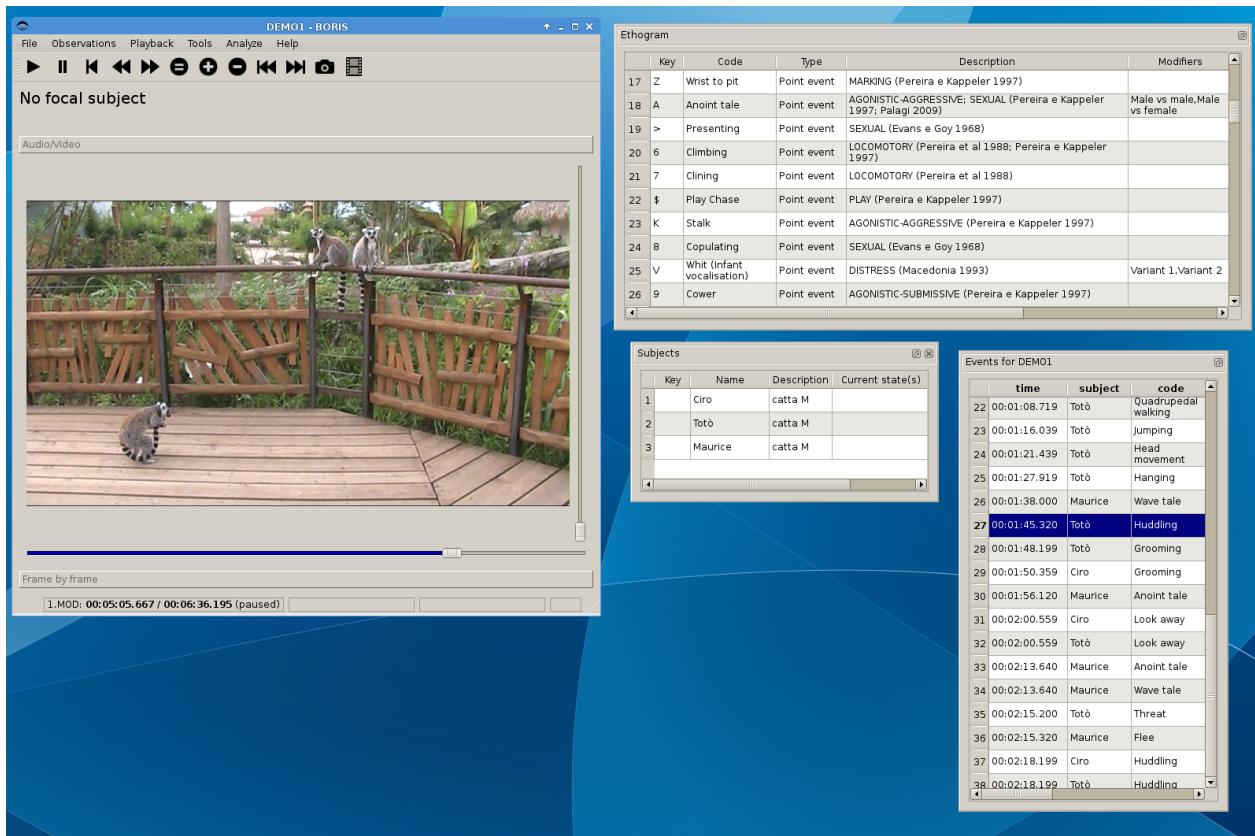
### Bug reports and features request

Please send bug reports and features request using the BORIS GitHub repository (<https://github.com/olivierfriard/BORIS>) or by e-mail in english, french or italian (see web site <http://www.boris.unito.it/pages/about.html>).

In case of bug report please verify that you are using the last version of BORIS and indicate your operating system, its version and the CPU architecture (32/64 bits). You may also include the BORIS project that gave you an error. Any information you will provide will not be disclosed to any third party.

### Docking

All elements, including the media player can be undocked from the main window and positioned where you prefer (e.g. they can be on the same desktop over one or two screens).



## Acknowledgement

The authors would like to acknowledge Sergio Castellano, Valentina Matteucci and Laura Ozella for their precious help.

## Valid keys for triggering behavior

BORIS will not make difference between lower case and upper case characters

- keys from A to Z
- keys from 0 to 9
- function keys from F1 to F12
- à é è ù ì ç
- ! " £ \$ % & / ( ) = ? ^ [ ] @ | § ° #