



## Second Joint Meeting of Société Zoologique de France and Unione Zoologica Italiana

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# BEHAVIORAL ANALYSIS WITH BORIS

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Torino, 18-09-2017





**www.boris.unito.it**



# INTRODUCTION

# Existing coding software

- **Noldus - Observer XT "Golden standard"**
  - Pros : Golden standard, numerous features
  - Cons : Price, only for Windows, codec problems
- **JWatcher**
  - Pros : Multi platform (GNU/Linux, Mac OSX and Windows), free of charge
  - Cons : Video player not integrated, No more developed
- **Mangold - Interact**
  - Pros : Complete analysis
  - Cons : Price, only for Windows

# Why BORIS?

- Quantitative aspects of the study of animal and human behavior are increasingly relevant to test hypotheses and find empirical support for them.
- At the same time, photo and video cameras can store a large number of video recordings and are often used to monitor the subjects remotely.
- Researchers frequently face the need to code considerable quantities of video recordings with relatively flexible software, often constrained by species-specific options or exact settings.

# Why BORIS?

- (Free &) Open source
- Flexible
- Part of an efficient process flow

# Availability

- BORIS is a free and open-source software
- BORIS is available for Microsoft-Windows, GNU/Linux and Mac OS X

# Why open source ?

- Source Code Availability
- Free Redistribution
- Derived Works
- Integrity of The Author's Source Code
- No Discrimination Against Persons or Groups
- No Discrimination Against Fields of Endeavor
- Distribution of License
- License Must Not Be Specific to a Product
- License Must Not Restrict Other Software
- License Must Be Technology-Neutral
- <http://opensource.org/osd>

# What is BORIS ?

- BORIS is an event logging software that allow:
- Video/Audio coding
  - It records the video/audio position at which keys are pressed.
- Live observation coding
  - It records the time at which keys are pressed.

# BORIS features

- Configuration of an unlimited number of subjects and behaviours
- Based on VLC libraries (a robust and versatile media player)
- Coding of media files at various playback speeds of in frame-by-frame mode
- Up to 2 media file can be synchronously played
- Media files can be enqueue for playing, the event time will be the cumulative tim over all media

# BORIS features

- Time budget analysis
- Events plot
- Spectrogram visualization
- Export data in open format for further analyses
- Etc...

	ANVIL (v. 5.1.12 for Linux)	Cowlog (v. 3.0.2)	Jwatcher (v. 1.0 for Linux)	Jwatcher VIDEO	Mangold INTERACT (Premium)	Noldus Observer XT (version 12.5)	Solomon Coder (v. 15.11.19)	BORIS (v. 2.95)
Licence	Freeware	Free and open source	Freeware	Freeware	Proprietary	Proprietary	Freeware	Free and open source
Time offsets of videos	✓	✓	✗	✓	✓	✓	✓	✓
Simultaneous media files	✗	✗	NA	✗	✓	✓	✗	2
Available for Microsoft® Windows™	32 and 64 bits	✓	✓	✓	✓	7, 8.1; 64 bits	✓	7, 8, 8.1, 10; 32 and 64 bits
Available for Apple Mac OS®	✓	✓	✓	✓	✗	✗	✗	10.8 - 10.11
Available for GNU/Linux	✓	✓	✓	✗	✗	✗	✗	✓
Spectrogram	✓	✗	✗	✗	✓	✓	✓	✓
Geometric measurements	✓	✗	✗	✗	✗	✗	✗	✓
Playback speed	✗	✓	NA	✓	✓	✓	✗	Yes (from 0.1x to 8x)
Time budget calculation	✓	✗	✓	✓	✓	✓	✓	✓
Coded data visualization	✓	✗	✗	✗	During coding	During coding	✓	A posteriori

# but BORIS ...

- is not an automatic video analysis system
- can not integrate other data acquisition system at the moment (?)
- Fork it and add your own functions!

# Resources

- Official web site
  - <http://www.boris.unito.it>
- Twitter account
  - [https://twitter.com/BORIS\\_behav\\_obs](https://twitter.com/BORIS_behav_obs)
- Source code and issue tracker
  - <http://github.com/olivierfriard/boris>
- User guide
  - <http://boris.readthedocs.io>
- Paper on Methods in Ecology and Evolution
  - <http://onlinelibrary.wiley.com/doi/10.1111/2041-210X.12584/epdf>



How to cite BORIS

# Friard & Gamba 2016 Methods Ecol Evol

## Methods in Ecology and Evolution



British Ecological Society

*Methods in Ecology and Evolution* 2016, 7, 1325–1330

doi: 10.1111/2041-210X.12584

### APPLICATION

## BORIS: a free, versatile open-source event-logging software for video/audio coding and live observations

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# Ethogram and Behaviors

The screenshot shows the BORIS software interface for behavioral observation. The top menu bar includes File, Observations, Playback, Tools, Analyze, and Help. The main window title is "DEMO1 - DEMO1 - BORIS".

**Ethogram:** A table of behavioral codes and types. The first few rows are:

	Key	Code	Type
1	Ç	Marking	Point event
2	*	Licking	State event
3	>	Presenting	State event
4	V	Purr	Point event
5	Z	Yawn	Point event
6	V	Chirp	Point event
7	V	Yip	Point event
8	6	Climbing	State event
9	Z	Yawning	Point event
10	7	Clining	State event
11	\$	Play Chase	Point event
12	K	Stalk	Point event
13	C	Watering	State event
14	8	Copulating	State event
15	V	Whit (Infant vocalisation)	Point event
16	9	Cower	Point event
17	5	Chewing	State event
18	Q	Sniffing	State event

**No focal subject:** A video preview window showing a lemur walking on a wooden boardwalk. The video controls at the bottom include a play/pause button, volume, and frame by frame navigation.

**Events for "DEMO1" observation:** A table of recorded events. The first few rows are:

	time	subject	code	type
22	00:00:54.800	Maurice	Anoint tale	
23	00:00:57.438	Totò	Look away	
24	00:00:58.759	Totò	Huddling	STOP
25	00:00:58.879	Totò	Sit	STOP
26	00:00:58.999	Totò	Depart	
27	00:00:59.959	Ciro	Huddling	STOP
28	00:01:00.199	Totò	Quadrupedal walking	START
29	00:01:01.874	Ciro	Sit	START
30	00:01:04.040	Totò	Passing by	
31	00:01:11.000	Totò	Passing by	
32	00:01:15.200	Totò	Quadrupedal walking	STOP
33	00:01:16.039	Totò	Jumping	
34	00:01:16.880	Totò	Hanging	START
35	00:01:21.439	Totò	Head movement	
36	00:01:28.399	Totò	Head movement	
37	00:01:38.000	Maurice	Wave tale	
38	00:01:44.114	Totò	Hanging	STOP
39	00:01:45.320	Totò	Huddling	START
40	00:01:45.800	Ciro	Huddling	START
41	00:01:47.600	Ciro	Grooming	START
42	00:01:48.199	Totò	Grooming	START
43	00:01:50.359	Ciro	Grooming	STOP
44	00:01:56.120	Maurice	Anoint tale	
45	00:02:00.559	Ciro	Look away	

**Subjects:** A table of tracked subjects. The first few rows are:

	Name	Description	Current state(s)
1	Ciro	catta M	Sit
2	Totò	catta M	Hanging
3	Maurice	catta M	

**Frame by frame:** A progress bar indicating the current frame in the video sequence.

# The Ethogram

## edit project

Information Ethogram Subjects Independent variables Observations

	Behavior type	Key	Code	Description
1	Point event	¢	Marking	MARKING (Jolly 1966; Mertl-Millhollen 2006; Palagi & Norscia 2009)
2	State event	*	Licking	EXPLORATORY (Jolly 1966)
3	State event	5	Chewing	FEEDING (Pereira et al 1988)
4	Point event	V	Cackle	AGONISTIC (Macedonia 1993)
5	Point event	L	Touch	AFFILIATIVE (Pereira & Kappeler 1997)
6	Point event	V	Squeal	AGONISTIC (Macedonia 1993)
7	Point event	V	Twitter	AGONISTIC (Macedonia 1993)
8	State event	X	Sleeping	RESTING (Jolly 1966)
9	Point event	Z	Wrist to pit	MARKING (Pereira & Kappeler 1997)
10	Point event	A	Anoint tale	AGONISTIC-AGGRESSIVE; SEXUAL (Pereira & Kappeler 1997; Palagi 2009)
11	State event	>	Presenting	SEXUAL (Evans & Goy 1968)
12	State event	6	Climbing	LOCOMOTORY (Pereira et al 1988; Pereira & Kappeler 1997)
13	Point event	Z	Yawning	RESTING (Pereira et al 1988)
14	State event	7	Clining	LOCOMOTORY (Pereira et al 1988)
15	Point event	\$	Play Chase	PLAY (Pereira & Kappeler 1997)
16	Point event	K	Stalk	AGONISTIC-AGGRESSIVE (Pereira & Kappeler 1997)
17	State event	C	Watering	FEEDING (Jolly 1966)
18	State event	8	Copulating	SEXUAL (Evans & Goy 1968)

Add behavior

Clone behavior

Remove behavior

Remove all behaviors

Exclusion matrix

Import behaviors  
from a BORIS project

Import from JWatcher

Import from text file

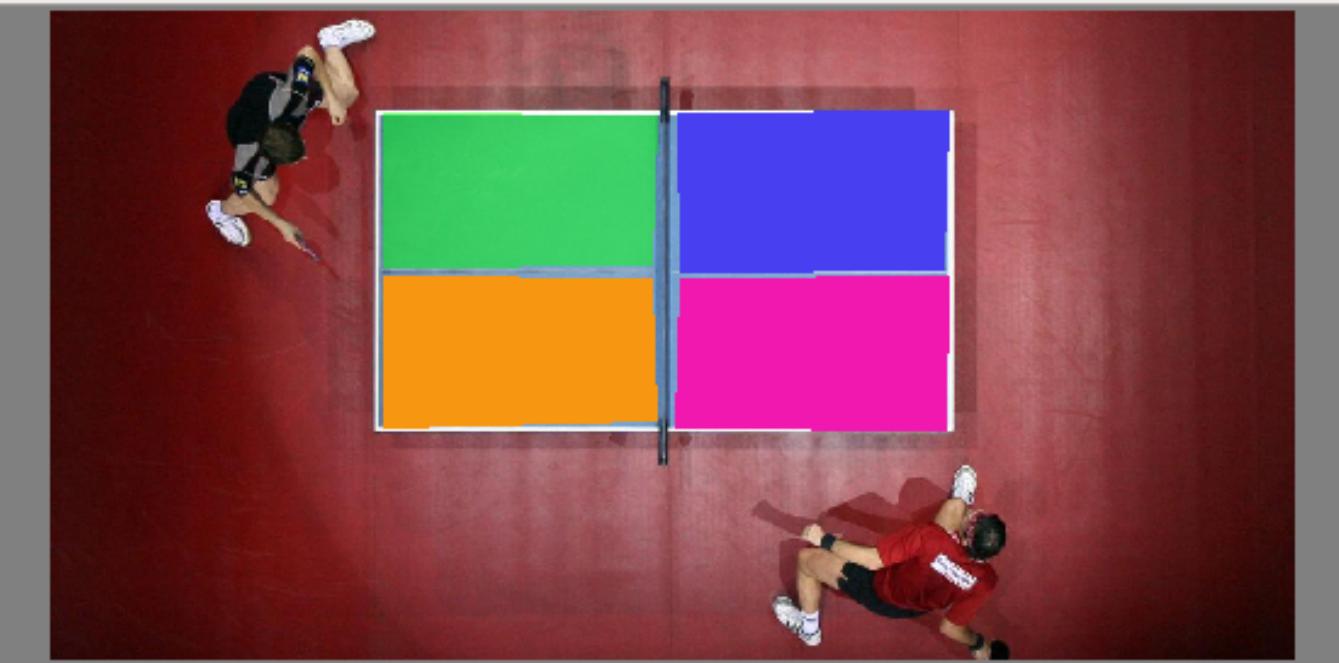
Cancel

OK

# Behaviors with a coding map

# BORIS - Map creator tool - pingpong

## Map creator



# BORIS - Map creator tool

## Map creator



“Prioritizing” behaviors

# Be consistent in what you code first!

- E.g.; social behaviors, then postures, then vocalizations
- E.g.; social behavior, the vocal behavior.
- E.g.; social behavior, recipient.



# Subjects

# edit project



Information

Ethogram

Subjects

Independent variables

Observations

Key	Subject name	Description
1	K	Kanki male, born october 28 - 1980
2	0	Boba female, born march 2 - 1983

Add subject

Remove subject

Import subjects  
from a BORIS project

Cancel

OK



# Observations

**Edit observation "observation #1"**

Observation id: **observation #1** Date: **2013-09-06 12:** ▾

Description:  
First observation at Zoom Torino

**Media** **Live**

**Media file paths**

	Path	Duration	FPS	Video	Audio
1	/home/user/Videos/lemurs.mp4	00:01:00.350	29.97		

**Add media** **Remove media** **Add all media from directory**

Visualize spectrogram  
 Stop ongoing state events between successive media files

**Independent variables**

Variable	Type	Value
1 meteo	text	
2 Group size	numeric	
3 Number of visitors	numeric	

**Media file paths for second player (will be played simultaneously)**

Path	Duration	FPS	Video	Audio

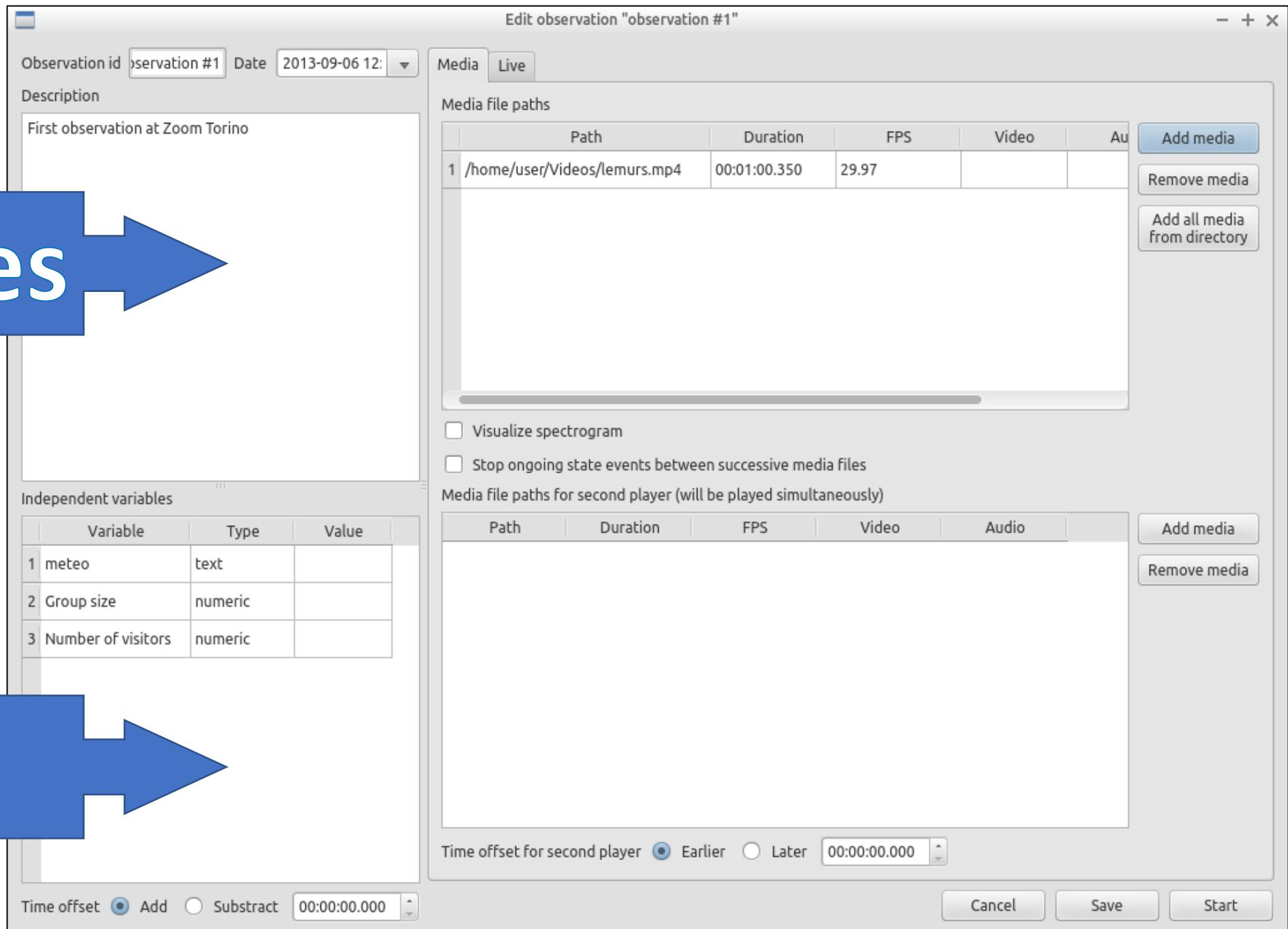
**Add media** **Remove media**

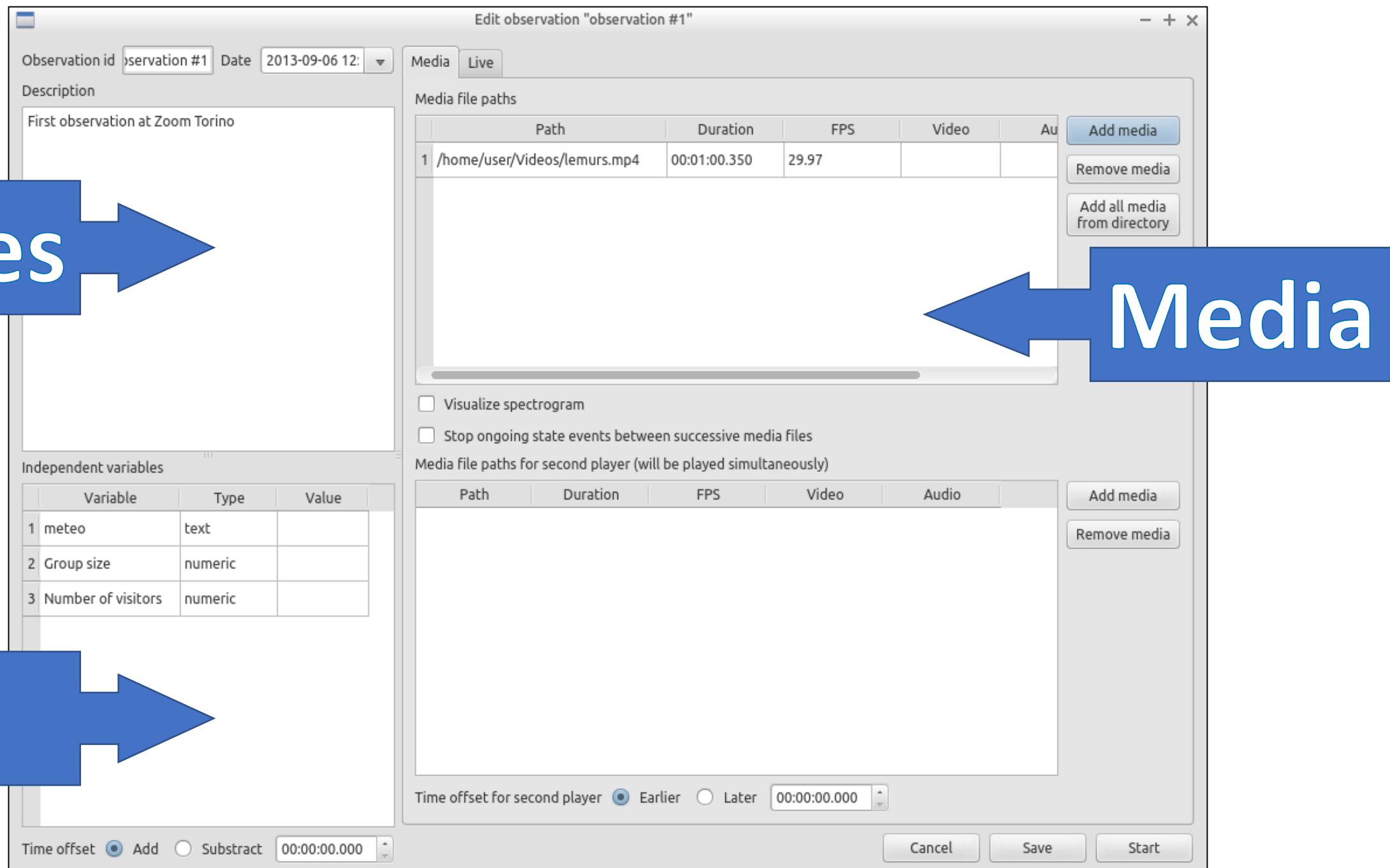
Time offset for second player:  Earlier  Later **00:00:00.000**

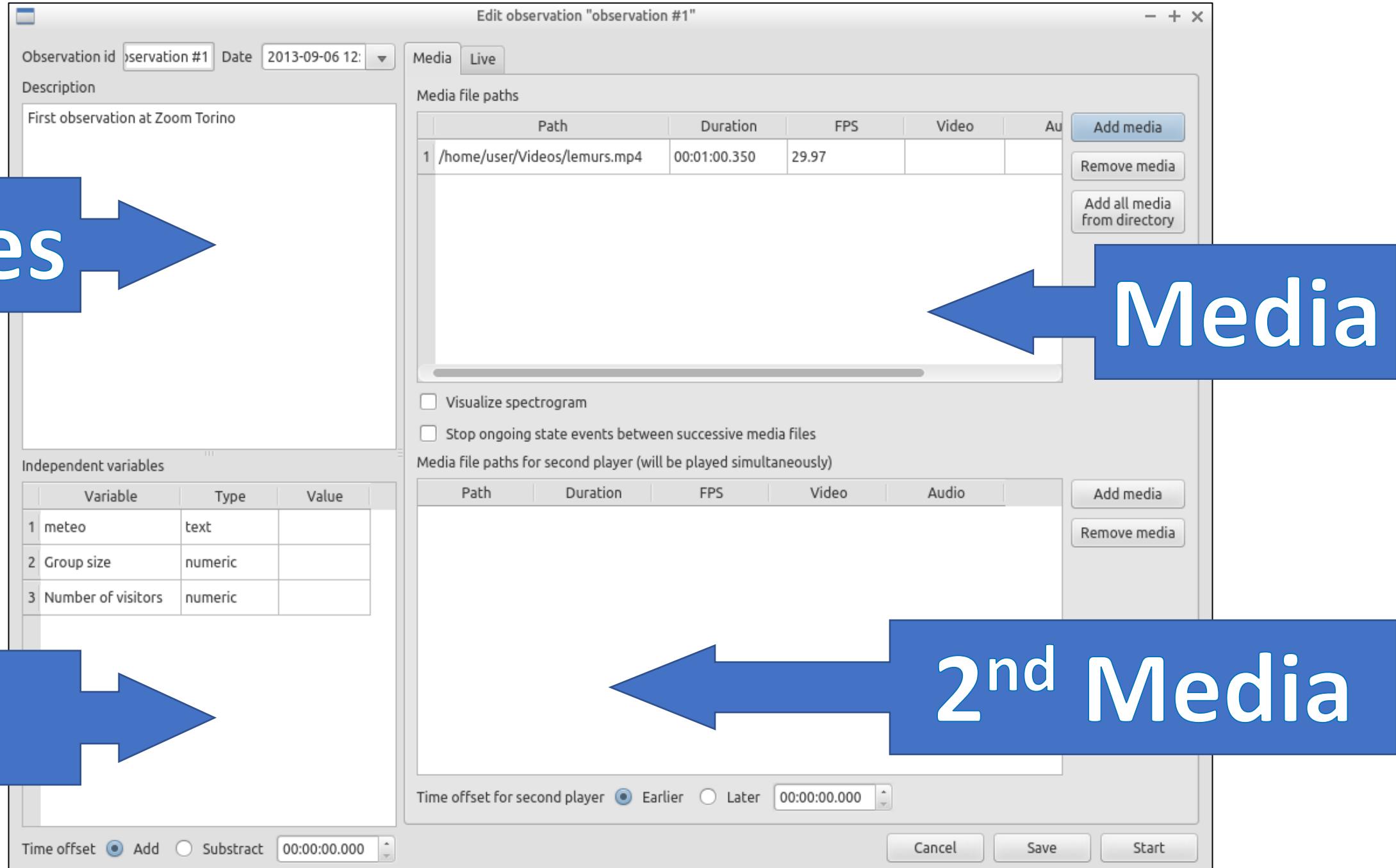
Time offset:  Add  Subtract **00:00:00.000**

**Cancel** **Save** **Start**

# Notes →



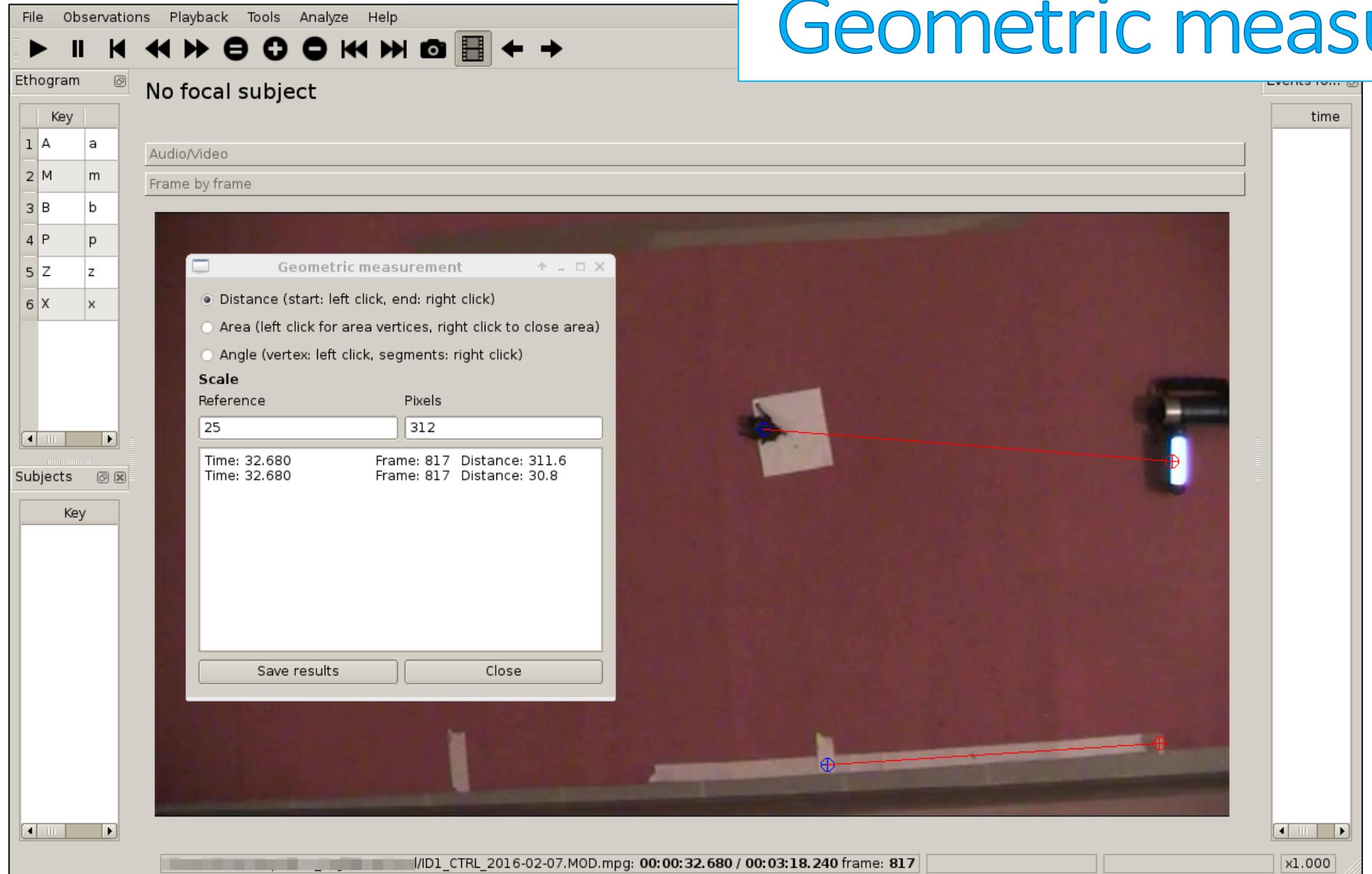






Tools

# Geometric measurement



# Time budget at a glance

Time budget

Selected observations  
DEM01

Total media length: 00:02:32.240

	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 media length
1	Ciro	Huddling	NA	2	77.041	38.521	8.657	45.841	NA	50.6
2	Ciro	Look away	NA	1	-	-	-	NA	NA	-
3	Maurice	Anoint tale	NA	3	-	-	-	39.42	30.971	-
4	Maurice	Flatten ears	NA	1	-	-	-	NA	NA	-
5	Maurice	Flee	NA	1	-	-	-	NA	NA	-
6	Maurice	Looking around	NA	2	7.321	3.661	1.445	29.4	NA	4.8
7	Maurice	Quadrupedal walking	NA	1	5.88	5.88	NA	NA	NA	3.9
8	Maurice	Sitting	NA	1	-	-	-	NA	NA	-
9	Maurice	Stalk	NA	2	-	-	-	32.4	NA	-
10	Maurice	Wave tale	NA	2	-	-	-	35.64	NA	-
11	Totò	Depart	NA	1	-	-	-	NA	NA	-
12	Totò	Hanging	NA	1	27.234	27.234	NA	NA	NA	17.9
13	Totò	Head movement	NA	2	-	-	-	6.96	NA	-
14	Totò	Huddling	NA	2	74.878	37.439	6.449	46.561	NA	49.2
15	Totò	Jumping	NA	2	-	-	-	72.839	NA	-
16	Totò	Look away	NA	2	-	-	-	63.121	NA	-
17	Totò	Passing by	NA	3	-	-	-	44.1	52.524	-
18	Totò	Quadrupedal walking	NA	UNPAIRED	UNPAIRED	UNPAIRED	UNPAIRED	UNPAIRED	UNPAIRED	-

Save results Close

# Time budget at a glance



# Spectrogram

lemurs with spectrogram - BORIS

File Observations Playback Tools Analyze Help

▶ □ ▶◀ ▶▶ = + - ▶◀ ▶▶ Camera Film

Ethogram No focal subject Events for lemurs with spectrogram

Spectrogram

Subjects

Key	Name	Description

Frame by frame

lemurs.mp4: 00:00:17.019 / 00:01:00.348 (paused) x1.000

The screenshot displays the BORIS software interface for behavioral observation. At the top, a menu bar includes File, Observations, Playback, Tools, Analyze, and Help. Below the menu is a toolbar with icons for play, pause, previous frame, next frame, zoom, and camera. The main window title is "lemurs with spectrogram - BORIS". On the left, an "Ethogram" section shows a status message "No focal subject". To the right, an "Events for lemurs with spectrogram" section contains a spectrogram visualization. The central part of the screen features a video frame showing several lemurs in an outdoor enclosure. One lemur is perched on a wooden structure, while others are on rocks. A blue vertical line marks a specific point in the spectrogram corresponding to the video frame. A timeline at the bottom indicates the video is at 00:00:17.019 of a total duration of 00:01:00.348, with playback paused. The zoom level is set to x1.000.



Hands-on # 1 (Geese)

# Download the videos

geese\_1-3.avi

[https://github.com/olivierfriard/BORIS\\_UZI\\_Workshop\\_2017/](https://github.com/olivierfriard/BORIS_UZI_Workshop_2017/)

geese\_1-3.avi

➤ **Create a new project**

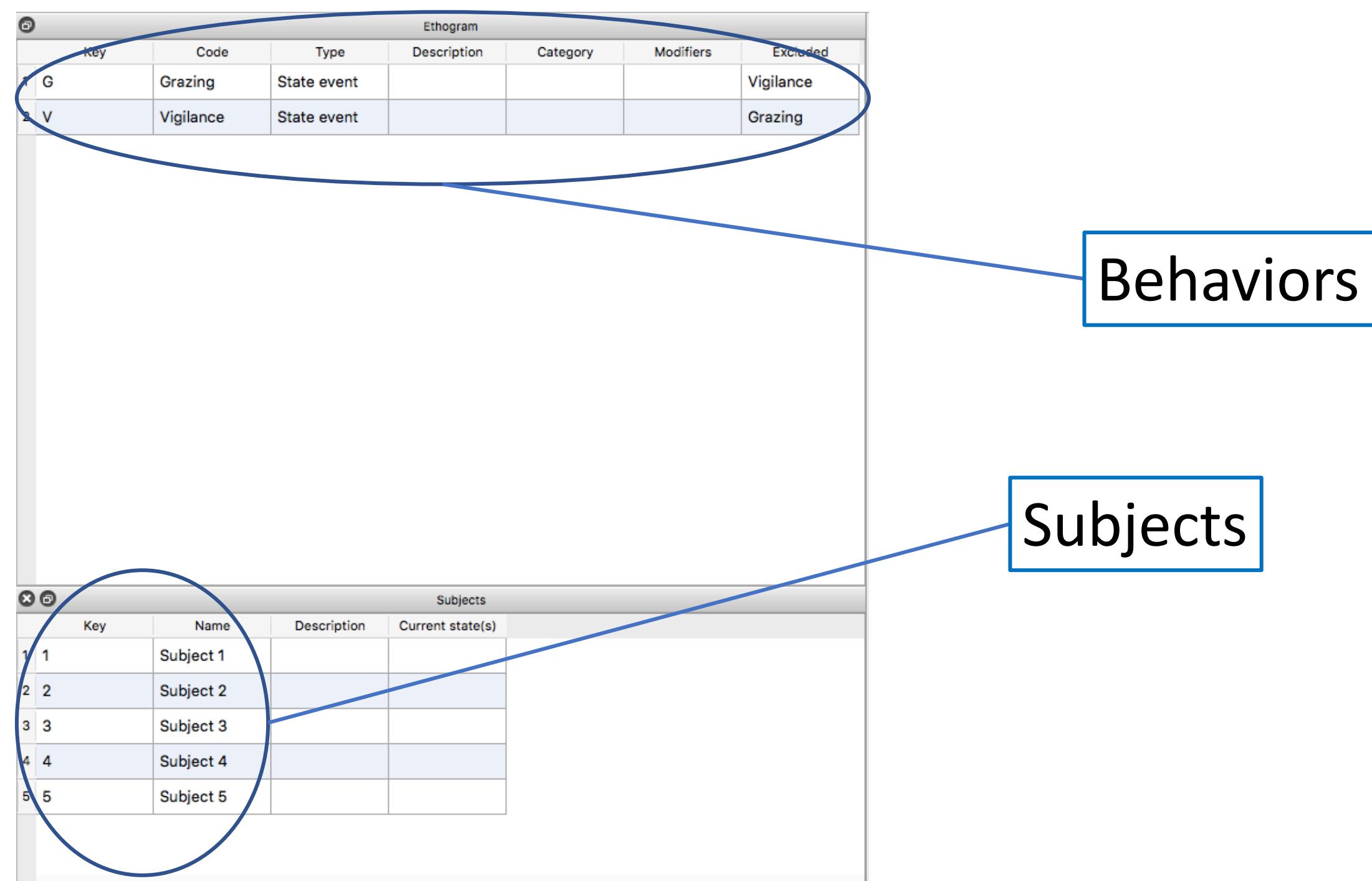
➤ **Set 5 subjects**

Insert 5 subjects SUBJECT 1 to 5 (Key: 1-5)

➤ **Set the ethogram**

Define two states: GRAZING (Key: G) and VIGILANCE (Key: V).

Set the Exclusion matrix to have mutually exclusive behaviors.



## ➤ Start an observation

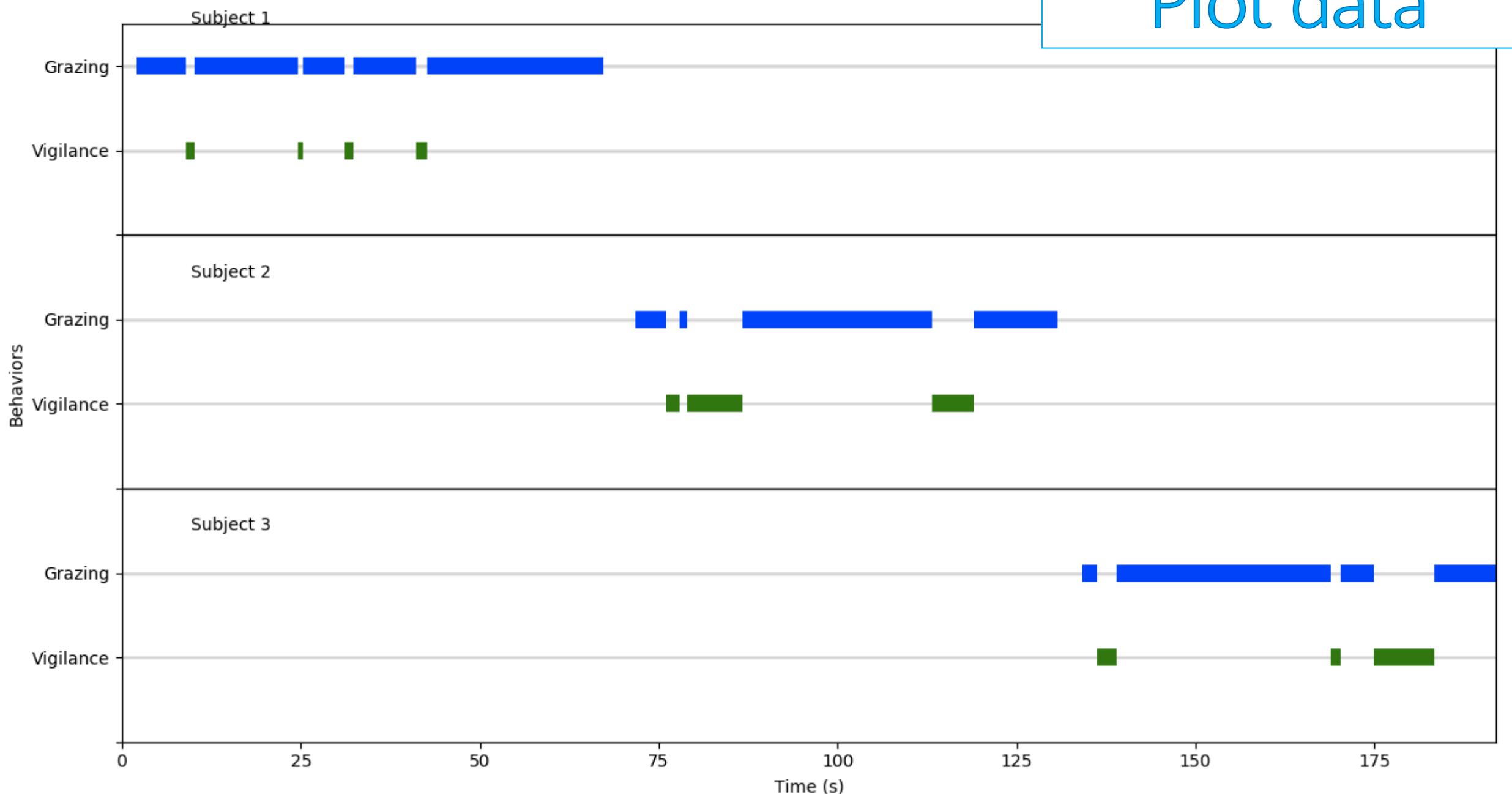
Observations > New observation (must have a unique ID)

## ➤ Load the video

Press the Start button to launch the observation

Time diagram of observation UZI17

Plot data



# Time budget at a glance

Selected observations

UZI17

Analysis from 0.000 to 191.920 s

	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 media length
1	Subject 1	Grazing	NA	5	60.639	12.128	7.734	1.182	0.403	31.6
2	Subject 1	Vigilance	NA	4	4.72	1.18	0.403	9.668	4.288	2.5
3	Subject 2	Grazing	NA	4	43.712	10.928	11.364	5.122	2.935	22.8
4	Subject 2	Vigilance	NA	3	15.359	5.12	2.935	13.78	18.073	8.0
5	Subject 3	Grazing	NA	4	45.218	11.305	12.695	4.16	3.659	23.6
6	Subject 3	Vigilance	NA	3	12.475	4.158	3.659	17.282	17.876	6.5



Hands-on # 2 (Baboons)

Download the video  
gelada1\_annotations.mp4:

[https://github.com/olivierfriard/BORIS\\_UZI\\_Workshop\\_2017/](https://github.com/olivierfriard/BORIS_UZI_Workshop_2017/)  
gelada1\_annotations.mp4

➤ **Open an existing project**

File > Open project > gelada.boris

➤ **Editing the project**

File > Edit project

➤ **Add modifiers**

Ethogram > (e.g.) Locomotion > double-click on the modifier column....

## ➤ Add set of modifiers

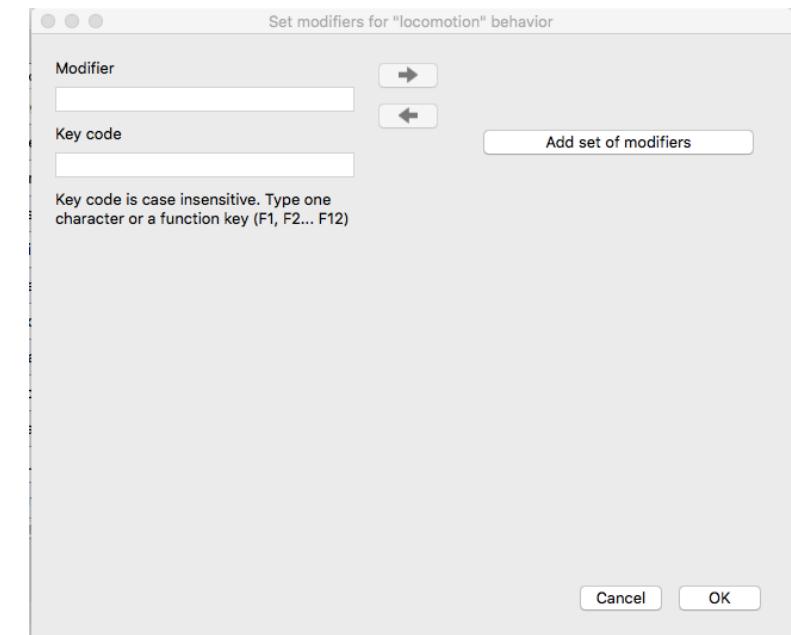
Click “Add set of modifiers”...

## ➤ Choose modifier type

Single selection, multiple selection, numeric...

## ➤ Add modifiers

Set name > add modifiers by filling in the desired names....





BORIS: Hands-on # 3 (Song)

Download the video  
indrison.mp4:

[https://github.com/olivierfriard/BORIS\\_UZI\\_Workshop\\_2017/](https://github.com/olivierfriard/BORIS_UZI_Workshop_2017/)  
indrison.mp4

Subjects

Key	Name	Description	ent sta
1 1	Singer1	Up in the video	
2 2	Singer2	Low in the video	

Subjects

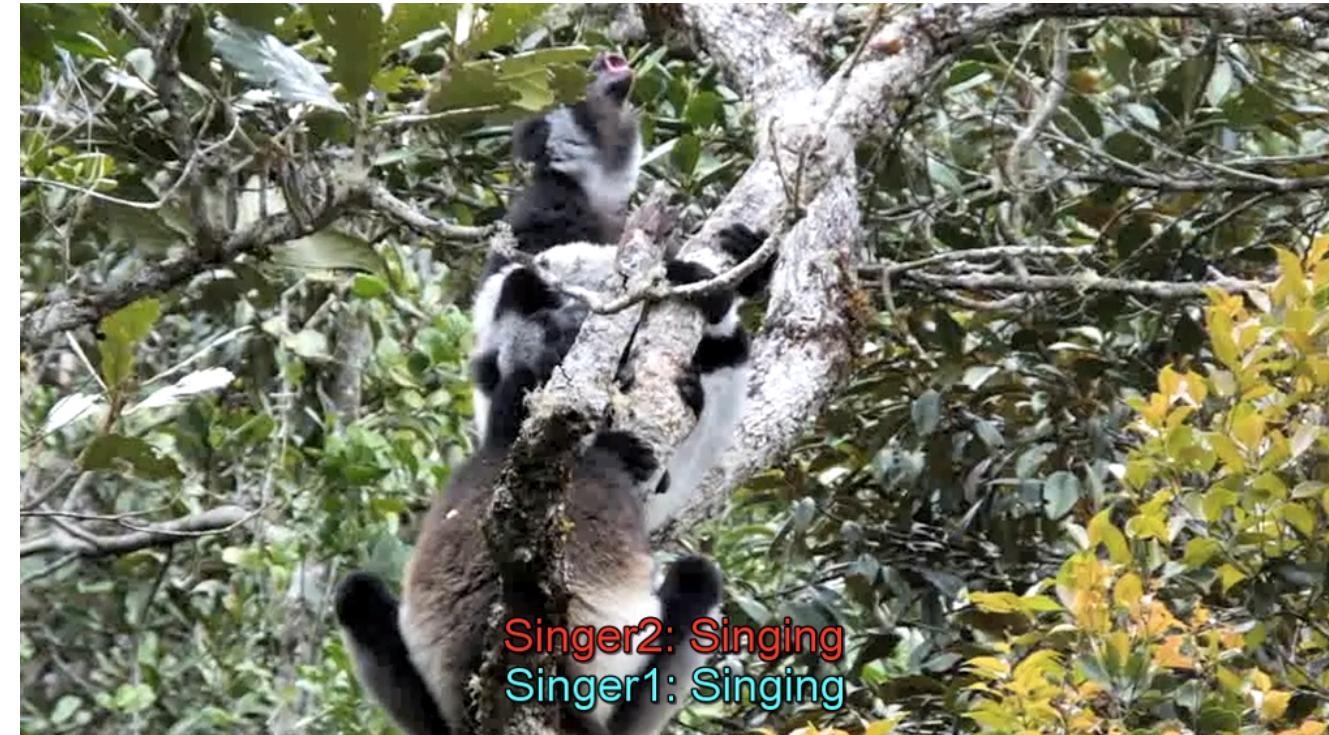
Key	Code	Type	Description
1 S	Singing	State event	

Behavior

➤ Proceed with your observation...Then...

Observations > Create subtitles

➤ Now you can open the video and the subtitles in VLC and see your coding as subtitles...





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



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