PythonVideoAnnotator Documentation

Release

Ricardo Jorge Vieira Ribeiro

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Getting Started

1 Quickest installation **3**
- 1.1 Installing . . . 3
- 1.2 Running . . . 3

2 For developers **5**
- 2.1 Installing . . . 5
- 2.2 Running . . . 6

3 Install DeepLabCut **7**

4 Update **9**

5 How to **11**
- 5.1 Project . . . 11
- 5.2 Video . . . 13

6 Timeline **23**
- 6.1 The timeline events . . . 23
- 6.2 Add and edit the properties of a row . . . 24
- 6.3 Show a dataset property on the timeline . . . 24
- 6.4 Import & export events . . . 25
- 6.5 Edit the graph's properties . . . 25
- 6.6 Convert graphs to events . . . 26

7 Shortcuts keys **29**
- 7.1 TIMELINE . . . 29
- 7.2 PLAYER . . . 30
- 7.3 SPECIAL KEYS . . . 30

8 Label DeepLabCut **31**
- 8.1 How to use . . . 31
- 8.2 Setup the project . . . 31
- 8.3 Importing from a YAML file . . . 32
- 8.4 Labeling the videos . . . 32
- 8.5 Exporting to a CSV file . . . 34
- 8.6 Result . . . 34

9 Path map **35**

9.1 How to use . . . 35
9.2 Result . . . 35
9.3 Example . . . 36

10 Track objects **37**
10.1 How to use . . . 38
10.2 Result . . . 43
10.3 Example . . . 43

11 Filter by regions **45**
11.1 How to use . . . 45
11.2 Result . . . 45
11.3 Example . . . 46

12 Extract the contour's images **47**
12.1 How to use . . . 47
12.2 Result . . . 49
12.3 Example . . . 49

13 Calculate the video background **51**
13.1 How to use . . . 51
13.2 Result . . . 52
13.3 Algorithm . . . 52
13.4 Example . . . 54

14 Smooth **55**
14.1 How to use . . . 55
14.2 Result . . . 56
14.3 Example . . . 56

15 Distances **57**
15.1 How to use . . . 57
15.2 Result . . . 57
15.3 Example . . . 58

16 Motion **59**
16.1 How to use . . . 59
16.2 Result . . . 60
16.3 Example . . . 60

17 Estimate the countour's orientation **61**
17.1 How to use . . . 61
17.2 Result . . . 62
17.3 Example . . . 62

18 Export videos **63**
18.1 How to use . . . 63
18.2 Result . . . 64
18.3 Example . . . 65

19 Export data **67**
19.1 How to use . . . 67
19.2 Result . . . 68
19.3 Example . . . 68

20 Project's tree **69**
20.1 Hierarchy . . . 70
20.2 Models definition . . . 70

21 Datasets **73**
21.1 Path . . . 73
21.2 Contours . . . 74

22 Project files **77**
22.1 timeline.csv file . . . 79
22.2 graphs folder . . . 79

23 Python Video Annotator's Documentation **81**
23.1 What is the Python Video Annotator? . . . 81
23.2 Funding . . . 84
23.3 Developers . . . 85

CHAPTER 1

Quickest installation

1.1 Installing

1. Install Python 3.6 from [python.org](https://www.python.org/)
2. Install pypi from pypi.org
3. Install PythonVideoAnnotator from Pypi:

```
pip install python-video-annotator
```

1.2 Running

1. Execute pythonvideoannotator:

```
start-video-annotator
```

CHAPTER 2

For developers

2.1 Installing

1. Download & install [Anaconda](https://www.anaconda.com/download/) or [Miniconda](https://conda.io/miniconda.html).

2. Download & install the environment configuration file:

for ubuntu:

```
conda install wget
wget https://raw.githubusercontent.com/UmSenhorQualquer/pythonVideoAnnotator/master/
↪utils/environment-ubuntu17.yml --no-check-certificate
conda env create -f environment-ubuntu17.yml
source activate videoannotator
```

for mac:

```
conda install wget
wget https://raw.githubusercontent.com/UmSenhorQualquer/pythonVideoAnnotator/master/
↪utils/environment-macosx.yml --no-check-certificate
conda env create -f environment-macosx.yml
source activate videoannotator
```

for windows:

Note: Make sure you are using the Anaconda prompt to execute the next commands.

```
conda install -c menpo wget
wget https://raw.githubusercontent.com/UmSenhorQualquer/pythonVideoAnnotator/master/
↪utils/environment-windows.yml --no-check-certificate
```

```
conda env create -f environment-windows.yml
conda activate videoannotator
```

3. Activate the environment, download the source code and install it:

for ubuntu, mac and windows:

```
git clone --recursive https://github.com/UmSenhorQualquer/pythonVideoAnnotator.git
cd pythonVideoAnnotator/utils
python install.py
```

2.2 Running

Run this command:

```
start-video-annotator
```

Or these commands:

```
source activate videoannotator
python -m pythonvideoannotator
```

CHAPTER 3

Install DeepLabCut

for windows and mac:

Run the following commands:

```
pip install deeplabcut
pip install -U wxPython
pip install --ignore-installed tensorflow==1.10
```

for linux:

Go to this link: https://extras.wxpython.org/wxPython4/extras/linux/gtk3/.
There you will have to choose your linux distribution and the wheel for Python 3.6.
Then run the commands under, but replace the middle command with whatever fits your linux distribution.

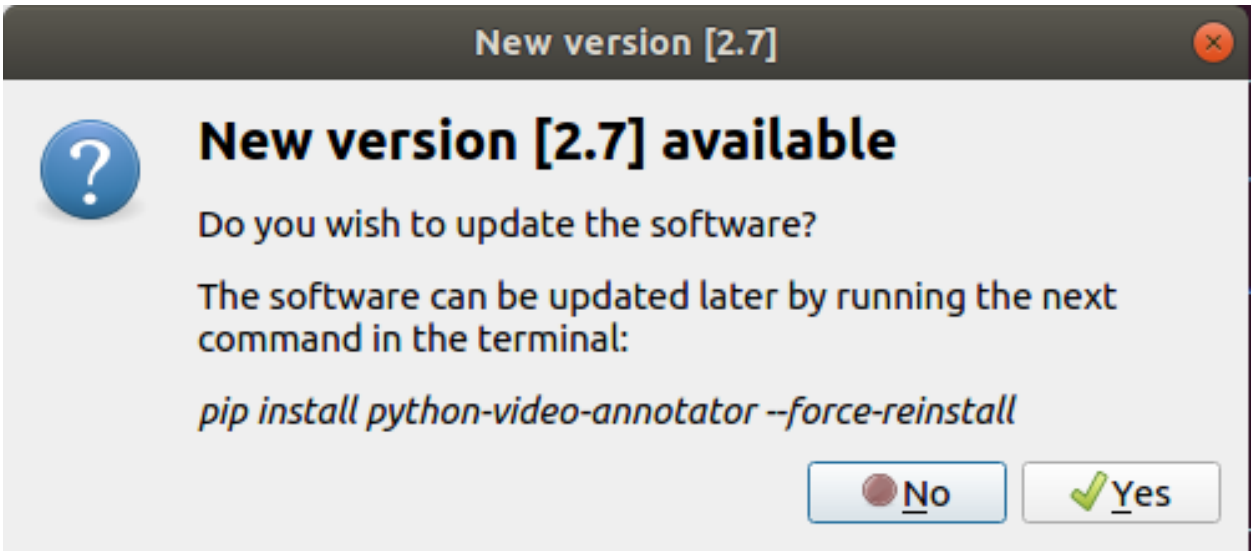
For example, if you have ubuntu 18.04, you will have to run the following commands:

```
pip install deeplabcut
pip install https://extras.wxpython.org/wxPython4/extras/linux/gtk3/ubuntu-18.04/
↪wxPython-4.0.4-cp36-cp36m-linux_x86_64.whl
pip install --ignore-installed tensorflow==1.10
```

CHAPTER 4

Update

If there is a newer version of Pythonvideoannotator available, a window like this one will appear when you run the application:



Simply click the **"Yes"** button and wait for the update to complete.

CHAPTER 5

How to

5.1 Project

By default the application opens with an empty project so you can start adding videos immediately.

5.1.1 Open a project

To open a existing project select the option **"Open"** in the **"File"** menu of the main window. A new window will appear asking for the project folder. You should select the folder and press open.

See also:

Find information about the project folders structure in the *Project tree* section.

5.1.2 Save a project

It is possible to save a project by using the options **"Save"** or **"Save as"** in the **"File"** menu of the main window.

Save

Update the current project files with the last changes.

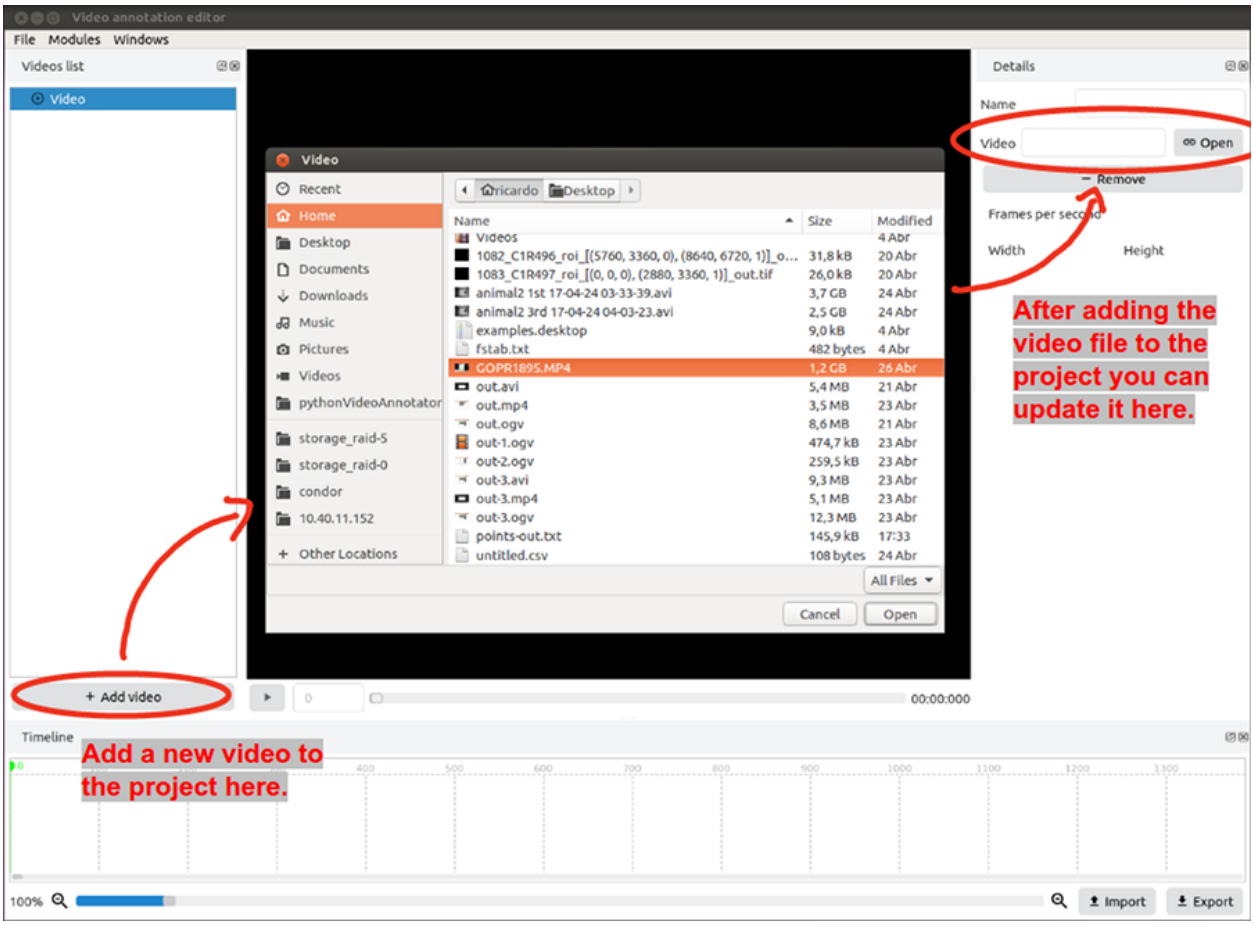
Note: If you are saving the project for the first time, this option will behave like the **"Save as"** option.

Save as

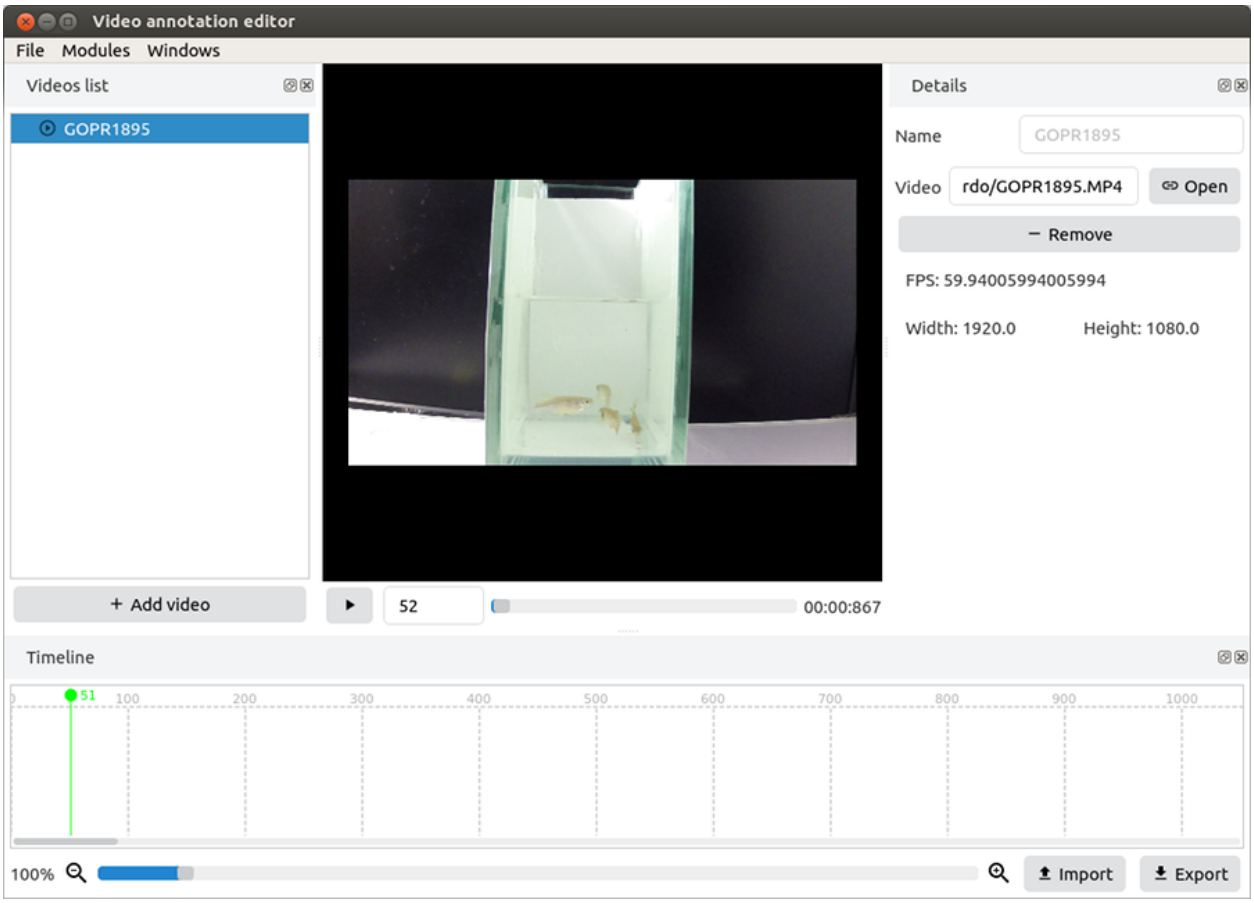
Save or export the current project into a folder.

Note: The user should choose an empty directory to avoid mixing the project files with pre existing files and directories.

5.1.3 Add a video



Result:

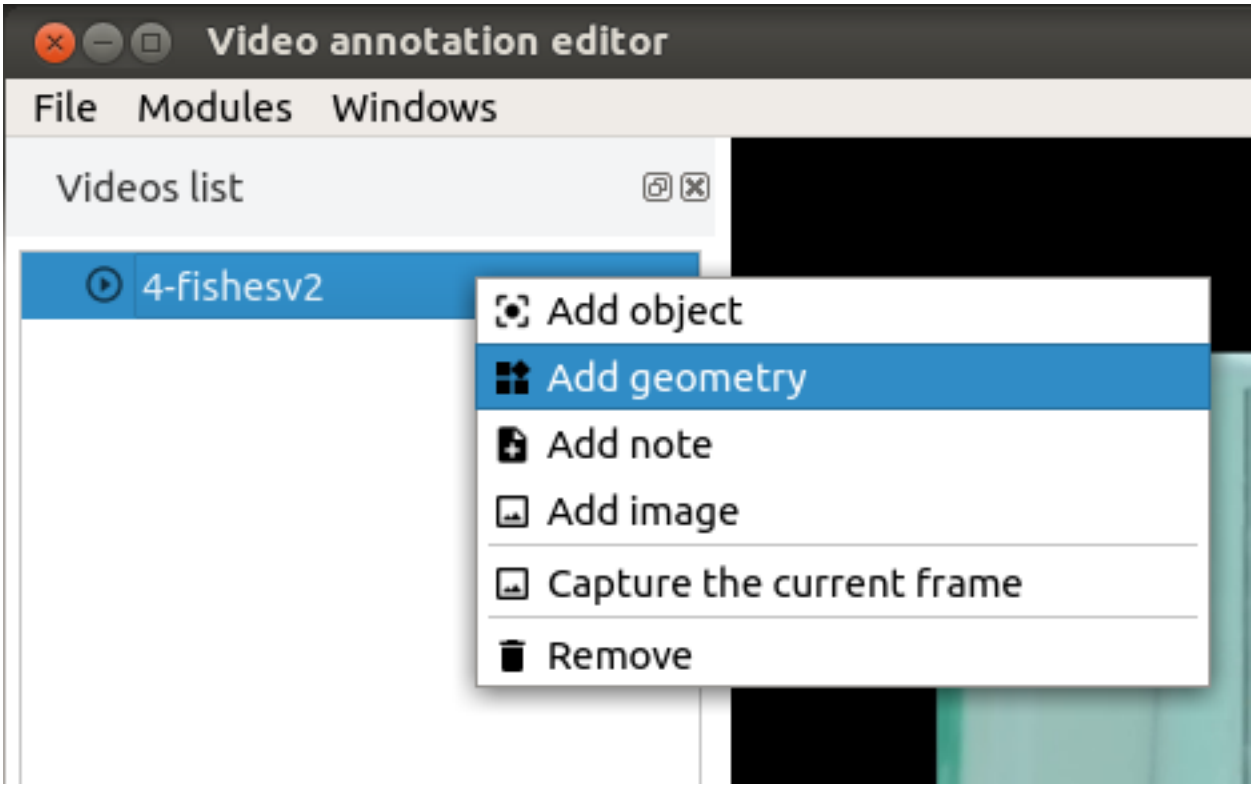


5.2 Video

You can right click a video to be able to add objects, geomtries, notes and images to it. You can also capture the current frame or remove the video.

5.2.1 Add & edit a geometry

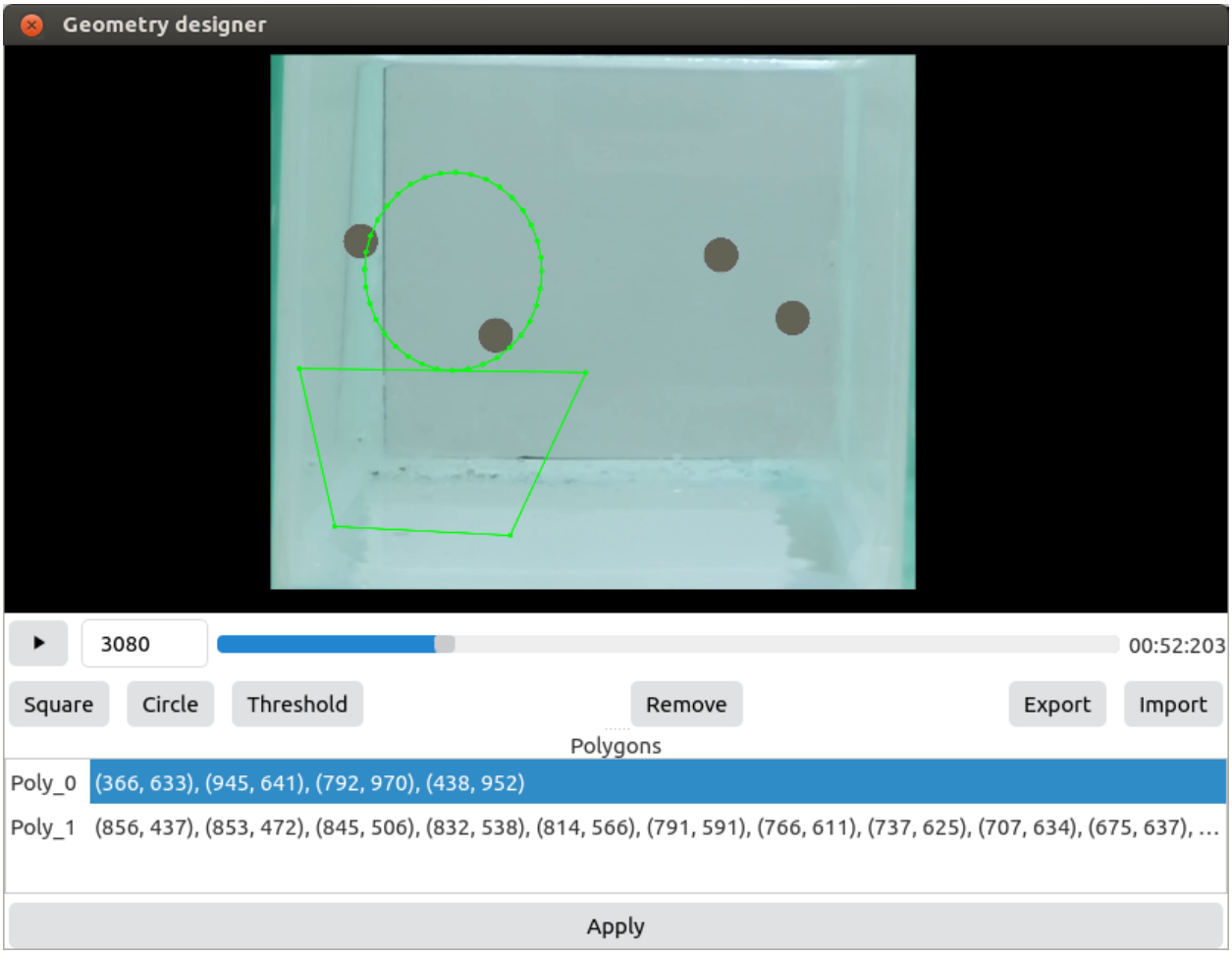
A geometry is used to define a region or a static object in the video. The geometries created will be displayed on top of the video. To edit a geometry, simply click on the **"Edit"** button on the right side of the window.



Drawing geometries

To draw a geometry, you should first select the type of geometry you would like to draw (Square or Cicle). Then, simply drag the mouse over the video to draw the polygon. You can zoom in and out using the mouse wheel.

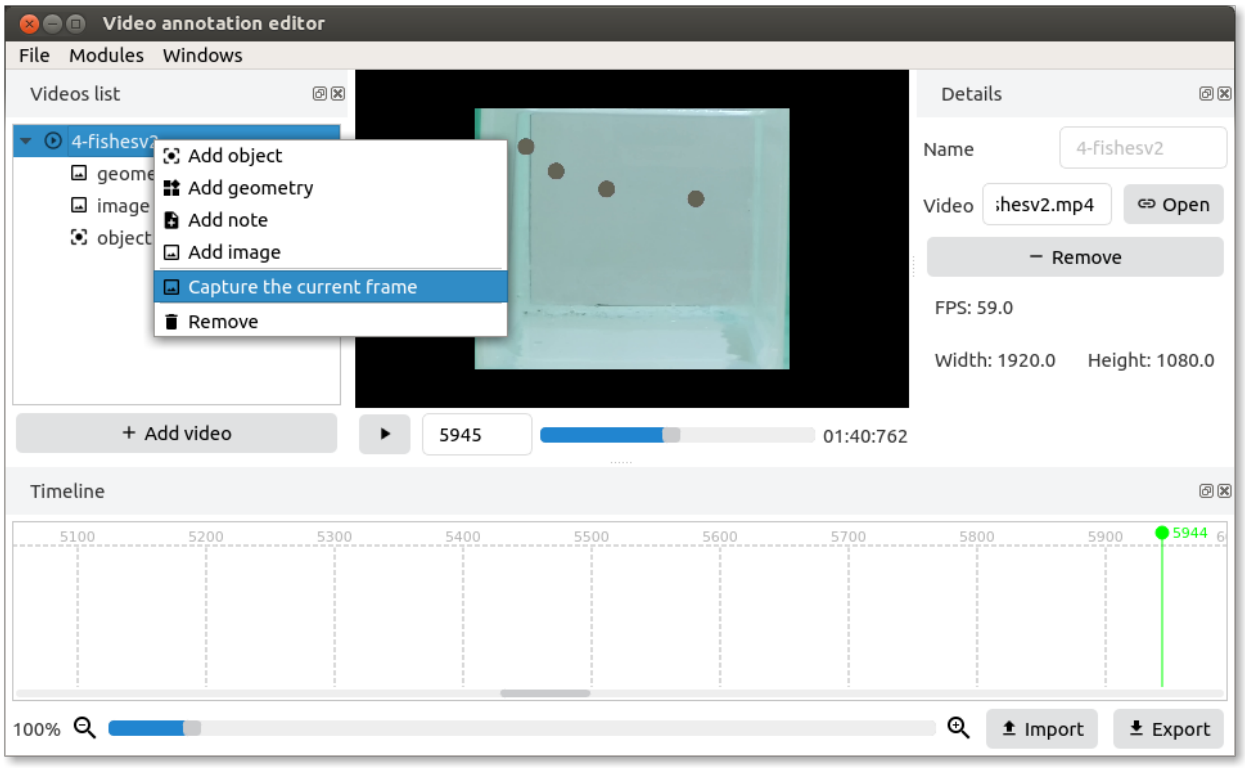
The **polygon points can be moved**, by dragging and dropping the selected point, or **deleted** by pressing the delete key on the keyboard. Once you're done, press **"Apply"** to confirm your changes.



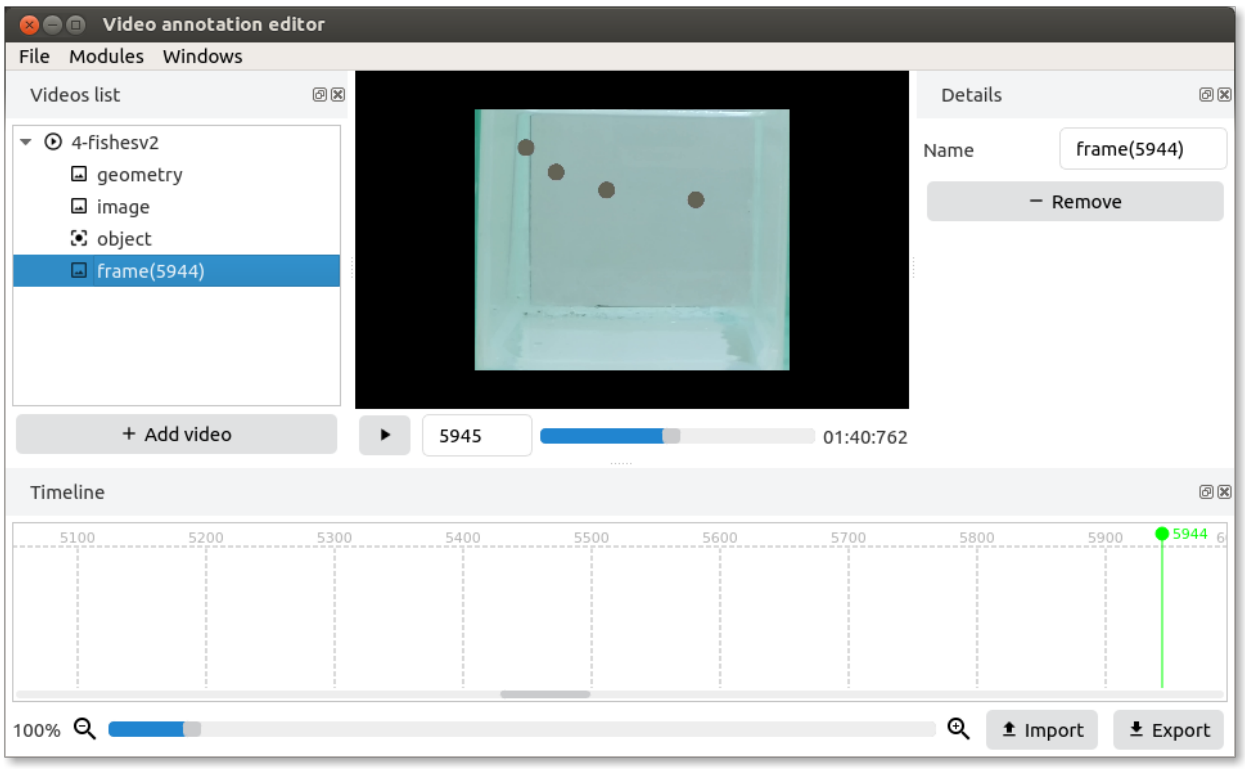
Example: Drawing a circle

5.2.2 Capture a frame

The next step can be used to capture the current frame into an image.

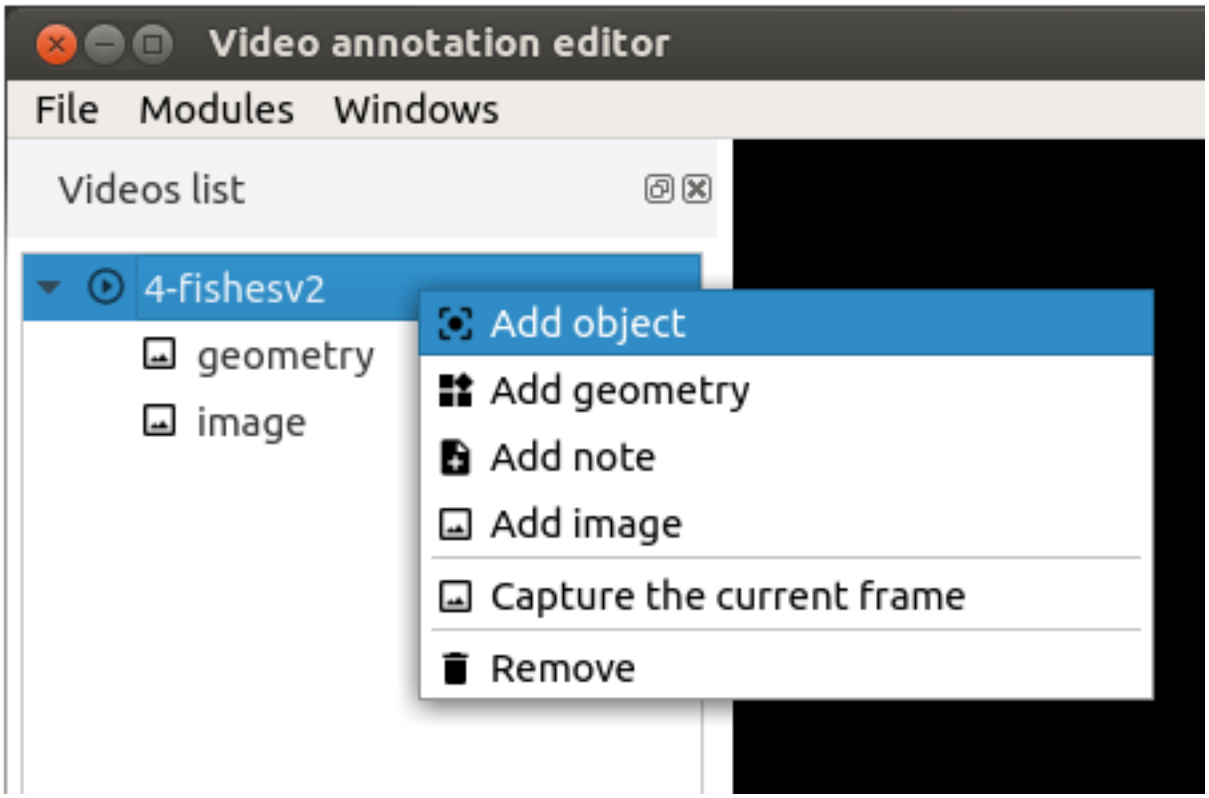

Video annotation editor
File
Modules
Windows
Videos list
4-fishesv2
geome
image
object
Add object
Add geometry
Add note
Add image
Capture the current frame
Remove
Details
Name
4-fishesv2
Video
shesv2.mp4
Open
Remove
FPS: 59.0
Width: 1920.0
Height: 1080.0
+ Add video
5945
01:40:762
Timeline
5100
5200
5300
5400
5500
5600
5700
5800
5900
5944
100%
Import
Export

Result:


Video annotation editor
File
Modules
Windows
Videos list
4-fishesv2
geometry
image
object
frame(5944)
Details
Name
frame(5944)
Remove
+ Add video
5945
01:40:762
Timeline
5100
5200
5300
5400
5500
5600
5700
5800
5900
5944
100%
Import
Export

5.2.3 Add an object

An object is something in the video whose properties change over time.



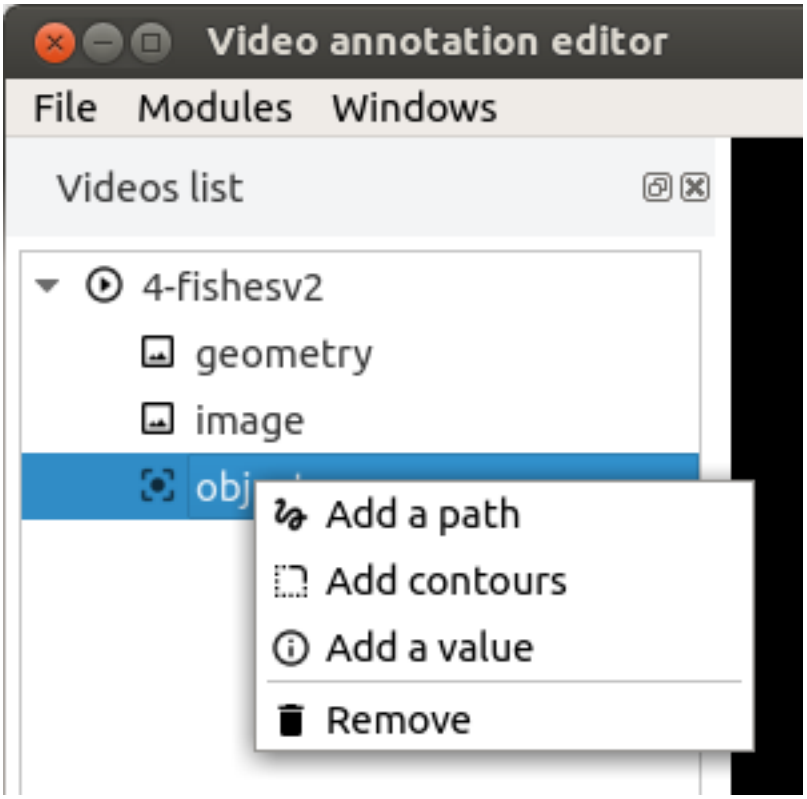
Add a dataset

A dataset is an object's property that changes over time. There are 3 types of properties that you can add: **Paths**, **Countours** or **Values**.

See also:

Find more information about the datasets in the *Objects' datasets* section.

To add a dataset right click over the object and select one of the available options.



Path

A path dataset stores information about an object's path.

Contours

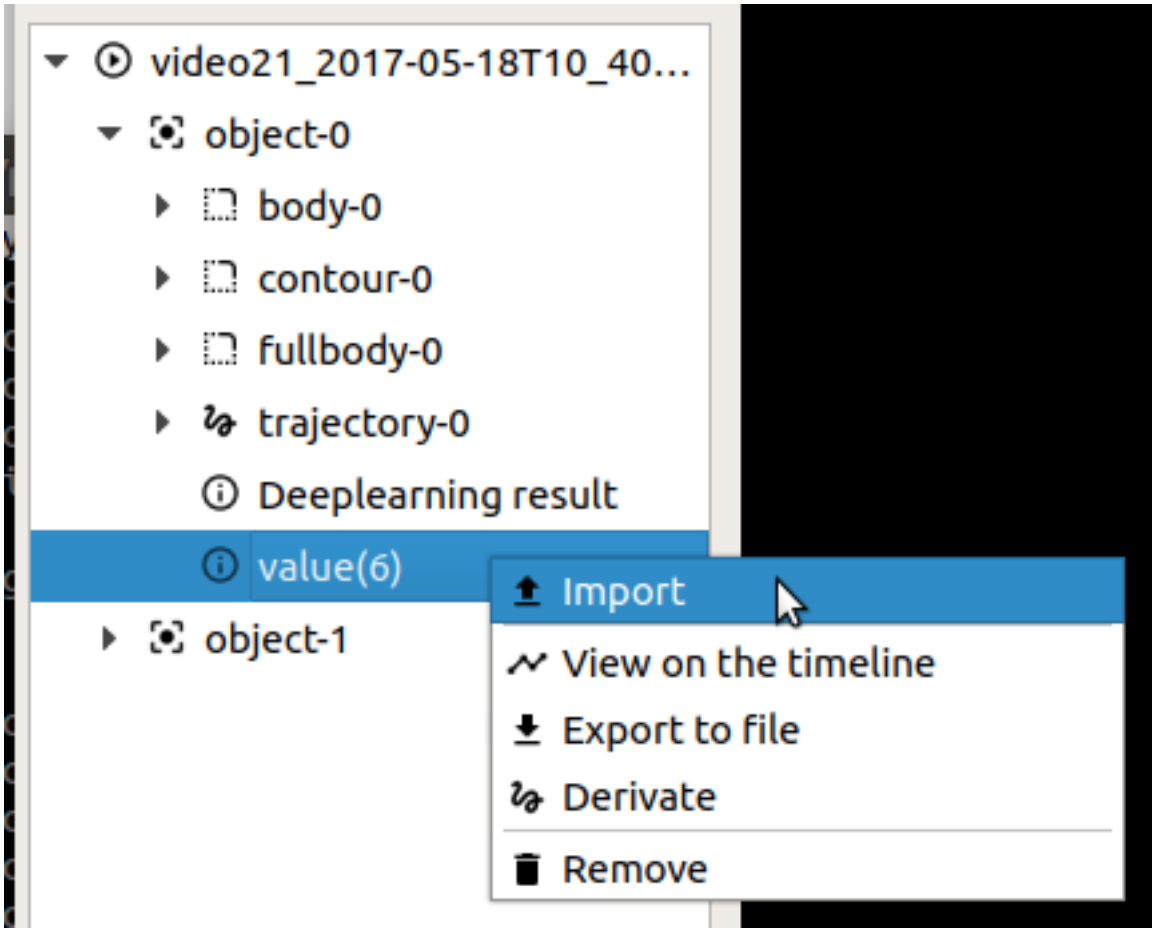
A contours dataset stores information about the object' contour over time, but it also has information about the object's path.

Value

This property stores any arbitrary number that can change over time. It can be used to store external data like for example hardware triggers.

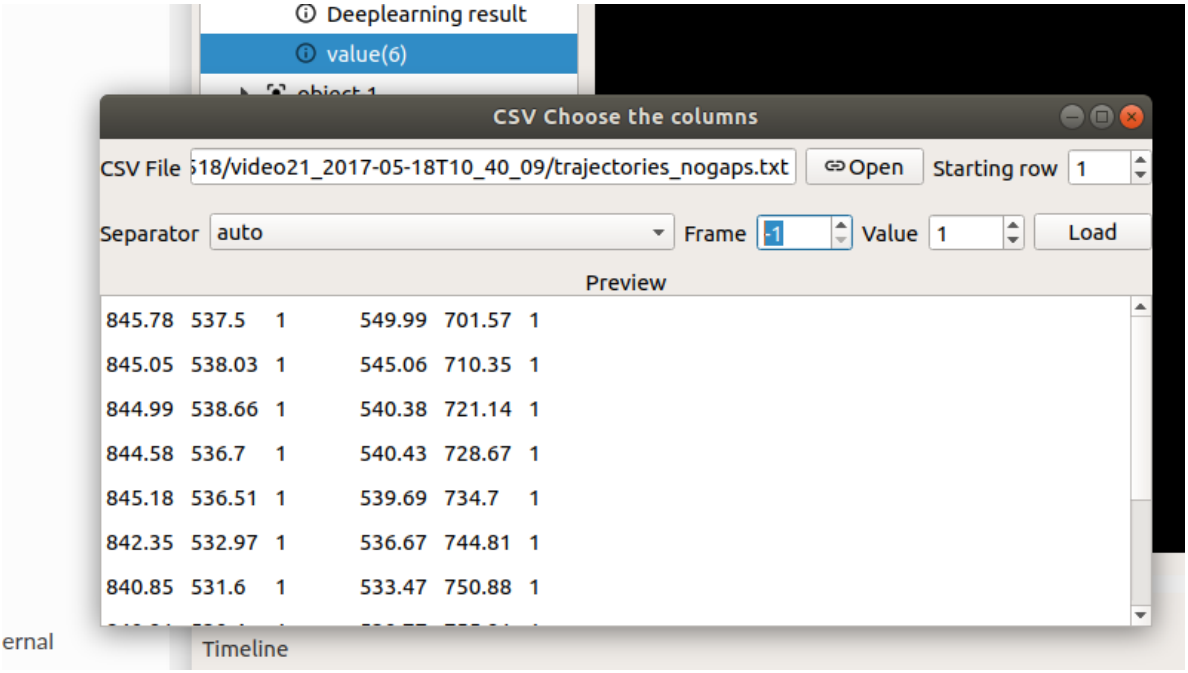
- **Import data from a CSV file**

  Right click over the value object in the project tree, and select the option **import**.



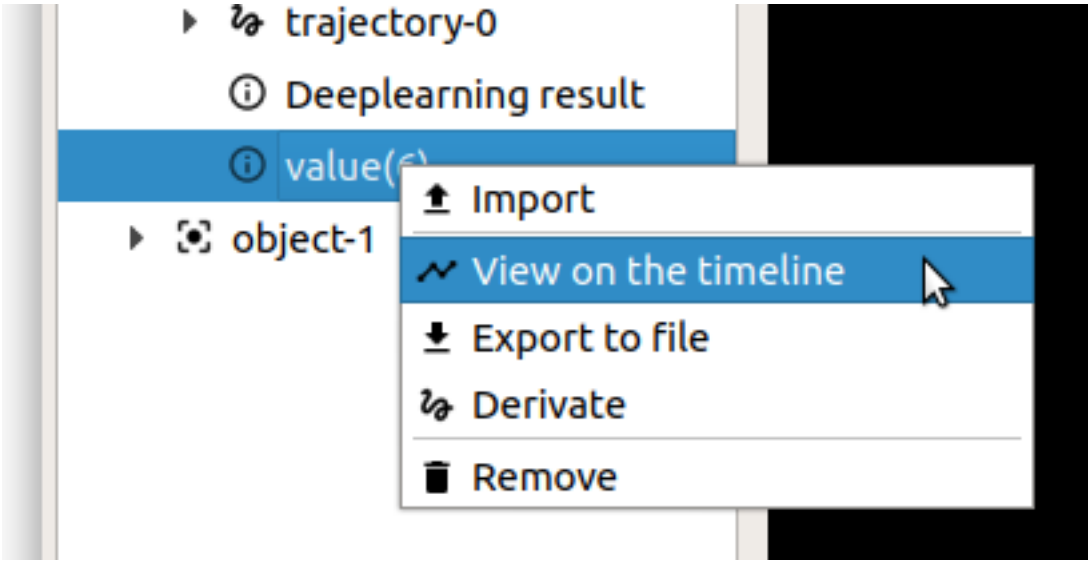
Choose the file, remove the file header (if it exists) using the starting row field and select the separator character. You will see a preview of the parsing of the file to import.

Then select the column corresponding to the number of the frame and to the value you would like to import. If the field **Frame** has the value -1 then it will be considered that the row number N corresponds to the N frame.

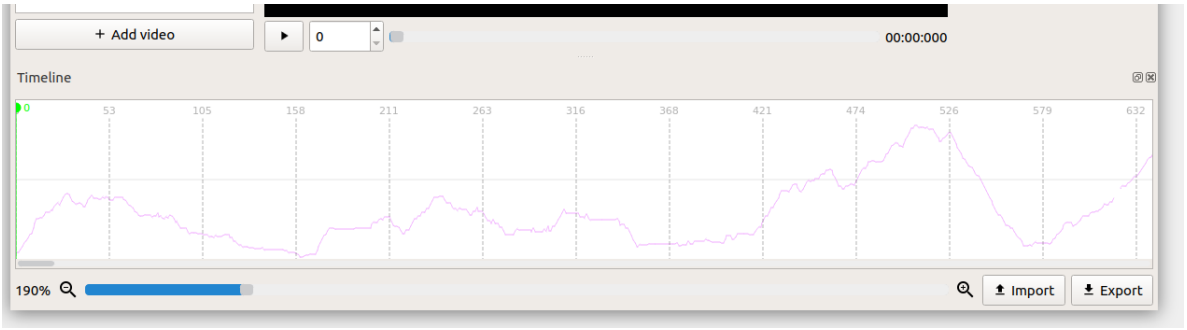


- **Display the value in the timeline**

Right click **"value"** and select the option **view on the timeline**.

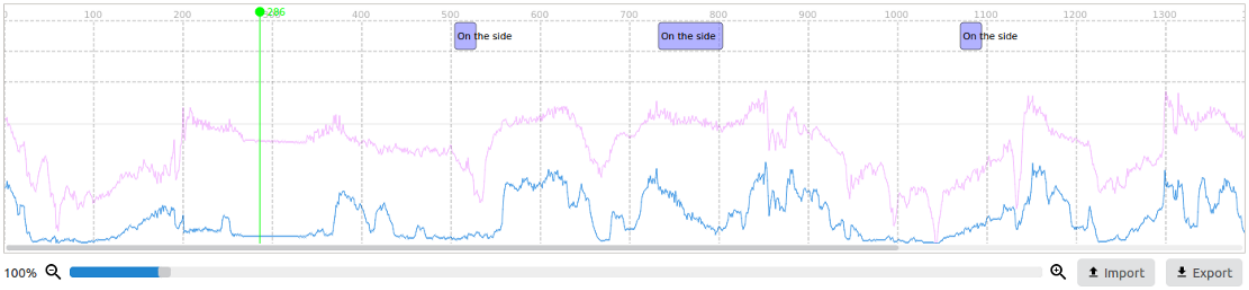


Result:


+ Add video
0
00:00:000
Timeline
0
53
105
158
211
263
316
368
421
474
526
579
632
190%
Import
Export

CHAPTER 6

Timeline



6.1 The timeline events

- **Create a new event:**
  - double-click on the track and time you wish to add a new event.
- **Rename the event label:**
  - double-click over the event.
- **Resize the event:**
  - drag the left and right side of the box until you reach the desired size.
- **Change the event color:**
  - right click over the event and choose the option “pick a color”.
- **Lock the edition of an event:**

  - right click over the event and choose the option “lock”.

- **Remove an event:**
  - right click over the event and choose the option “remove”.

Example: Creating, editing and deleting a note

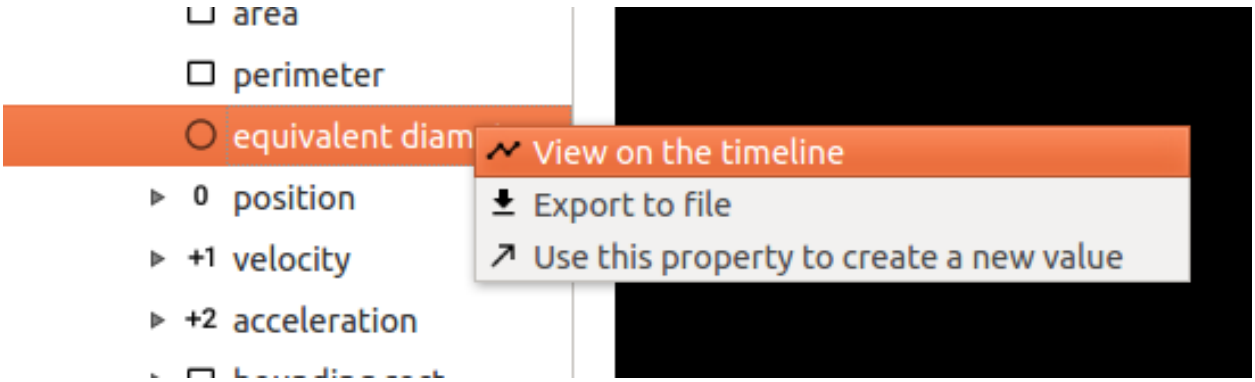
6.2 Add and edit the properties of a row

With the mouse over a row, click on the right mouse button and choose the option **“Row properties”**. A new window will appear.
On this window you can set the label for the row and the color that the new events will have.

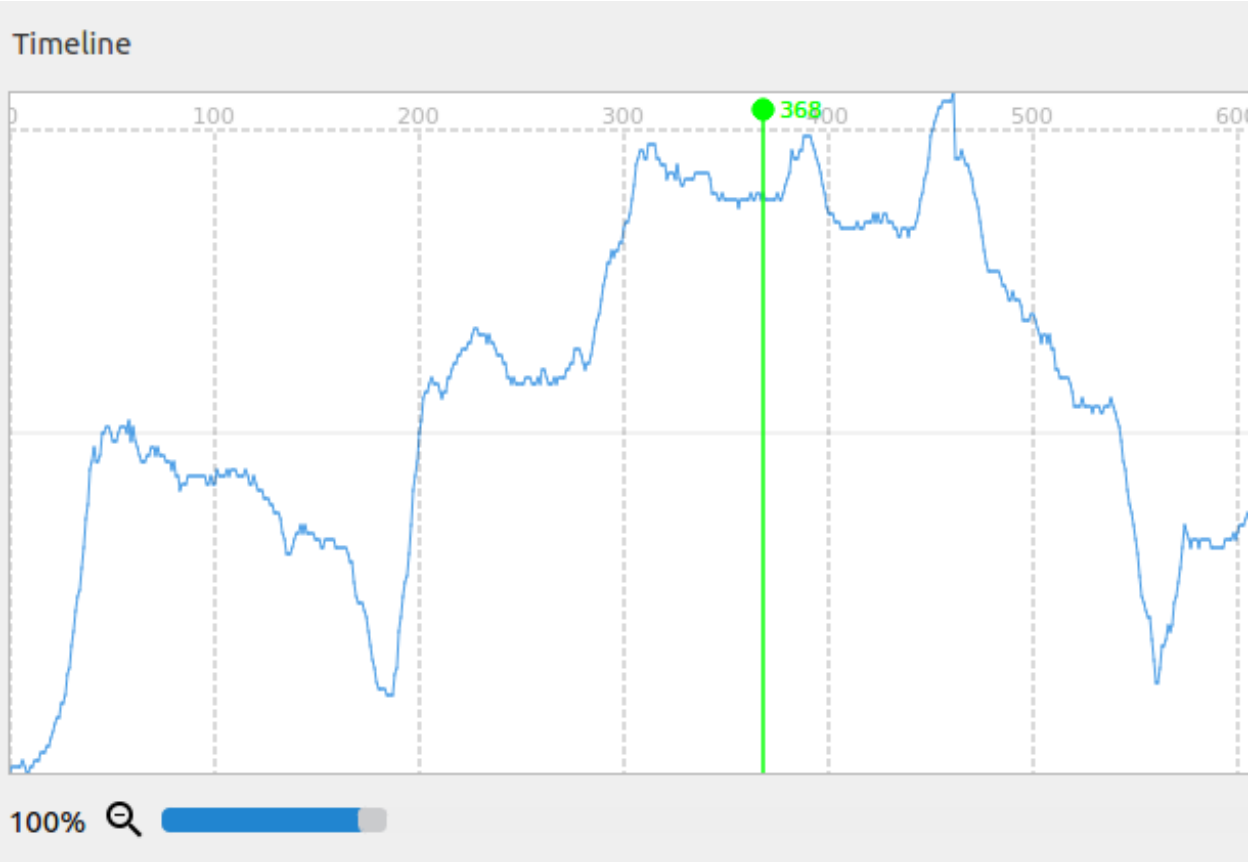
Example: Adding and editing rows

6.3 Show a dataset property on the timeline

On the project’s tree select the dataset property you want to graph on the timeline, press the right button of the mouse and select the option **“View on the timeline”**. The graph of the property will then be shown on the timeline.



Result:



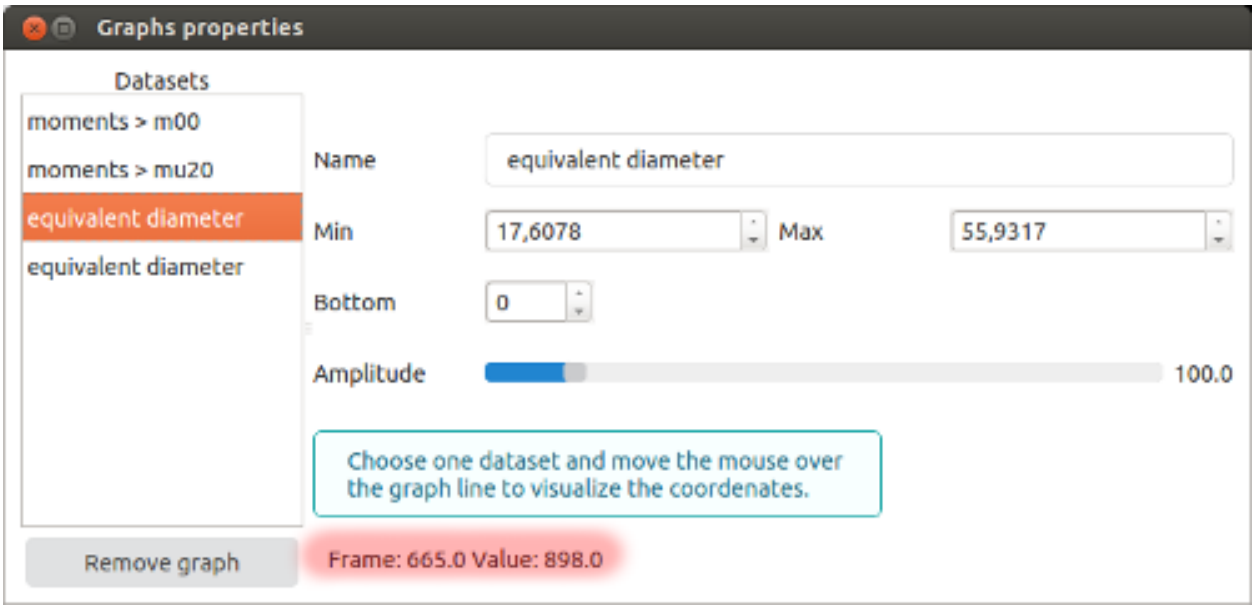
6.4 Import & export events

Use the buttons on the bottom right side to export events to a csv file or import graphs, events or bonsai events files.

6.5 Edit the graph's properties

Press the right mouse button and select the **"Graphs"** option to access the graphs' properties windows.
On this windows it's possible to edit the graphs' names and their displays.

Also, you can use this window to visualize the value of a graph at a certain point in time. Just select the graph and as you pass the mouse over the timeline, the value of the graph at a certain frame will be displayed on the window.



6.6 Convert graphs to events

Right click the timeline and select the option **"Convert graphs to events"**.

A new window will be shown. On the left-side list, double click on the graph you would like to use for the equation, and write the rest of it.

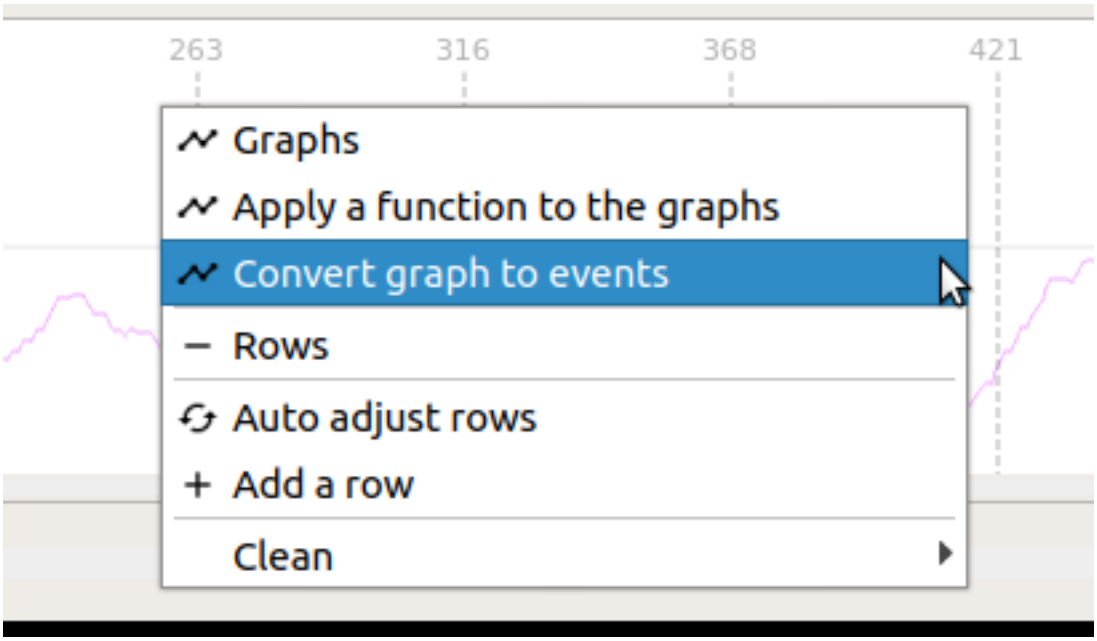
Use the fields **Event name** to define the name of the new events, use the **row number** field to define the row where the events should be created, and the **Minimum number of frames** to define the necessary number of consecutive frames where the equation is verified to create the events.

Equation example:

```
[Deeplearning result]>0.5 and [value(6)]<10
```

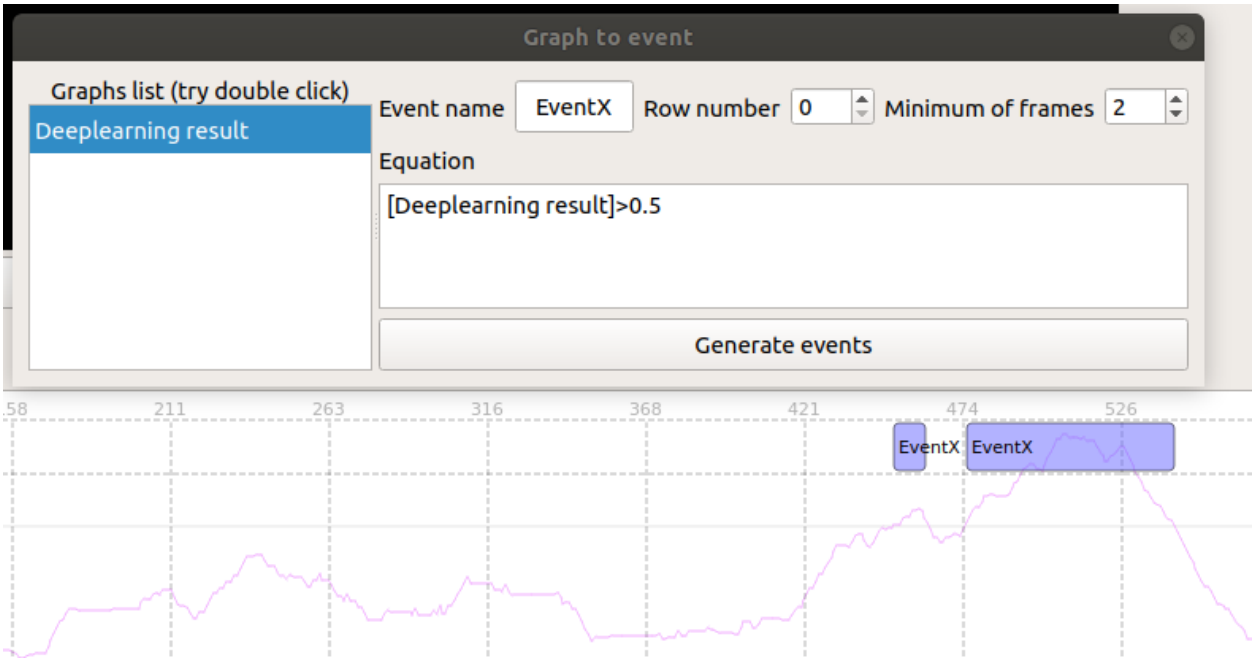
Note: Use spaces only between logic operators: **and** or **or**.

1. Right click the timeline and choose the option **"Convert graphs to events"**



2. Write the equation

3. Choose the name for the events, the minimum number of frames and the row they will be displayed in



CHAPTER 7

Shortcuts keys

This is a list of useful shortcuts for the application. The list shows the button used for the shortcut along with an explanation of what the shortcut does.

7.1 TIMELINE

EVENT	SHORT KEYS
Move the end of the selected event to the left.	Alt+Shift+Num+Left
Move the end of the selected event to the right.	Alt+Shift+Num+Right
Move the begin of the selected event to the left.	Ctrl+Alt+Num+Left
Move the begin of the selected event to the right.	Ctrl+Alt+Num+Right
Move the selected event to the left.	Alt+Num+Left
Move the selected event to the right.	Alt+Num+Right
Move the selected event to the track above.	Alt+Num+Up
Move the selected event to the track bellow.	Alt+Num+Down
Delete the selected event.	Alt+Del
Open or close a new event.	Alt+C
Lock or unlock the selected event.	Alt+L
Select the first event.	Alt+Q
Select the last event.	Alt+D
Select the next event.	Alt+D
Select the previous event.	Alt+A

7.2 PLAYER

EVENT	SHORT KEYS
Play or pause the video.	Meta+Space
Jumps 1 frame backward.	Meta+Alt+Num+Left
Jumps 1 frame forward.	Meta+Alt+Num+Right
Jumps 20 seconds backward.	Meta+Shift+Num+Left
Jumps 20 seconds forward.	Meta+Shift+Num+Right
Set player speed to 1x.	Meta+1
Set player speed to 2x.	Meta+2
Set player speed to 3x.	Meta+3
Set player speed to 4x.	Meta+4
Set player speed to 5x.	Meta+5
Set player speed to 6x.	Meta+6
Set player speed to 7x.	Meta+7
Set player speed to 8x.	Meta+8
Set player speed to 9x.	Meta+9

7.3 SPECIAL KEYS

EVENT	SHORT KEYS
Go to the next event and then click the mark the point button.	Ctrl+I
Select the path of the next object and click the mark the point button.	Ctrl+U
“Click” the Mark Point button in the current Path.	Ctrl+O

CHAPTER 8

Label DeepLabCut

This module allows you to label a video according to a DeepLabCut config file. Read more about DeeplabCut here: DeepLabCut.

8.1 How to use

1. *Setup the project.*

2. *Import the videos to label from a YAML file.*

3. *Label the videos.*

4. *Export the labeled videos to a CSV file.*

8.2 Setup the project

1. Create a directory for your project. You can name it whatever you want.

2. Create a yaml config file for the project. Put it in the project directory.

The config file should contain the path to all the videos you want to label, the path to your project directory, the parts you want to label and the number of frames you want to label. This is an example of how it should be structured: `config file`.

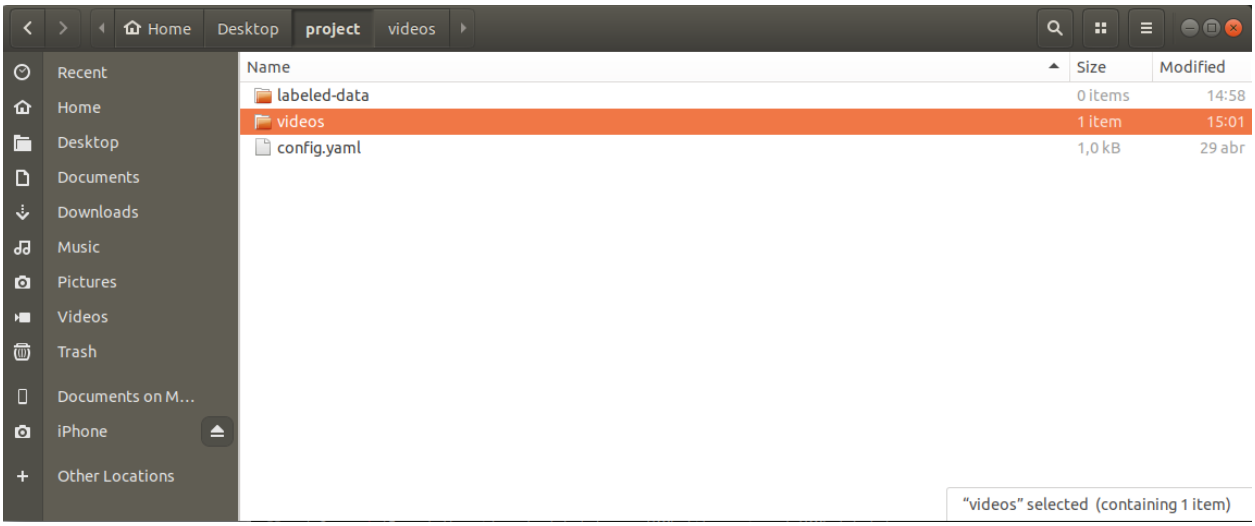
You can download the file and change it to suit your project.

3. Create a directory named **"videos"** inside the project directory.

4. Put all the videos you want to label inside the **"videos"** directory.

5. Create a directory named **"labeled-data"** inside the project directory.

The parent directory should now look like this:



6. This step is done. Now move to the next step of *importing the videos.*

8.3 Importing from a YAML file

1. Open the **"Modules"** tab and choose the **"Label DeepLabCut"** module.

2. Choose the yaml to import from. To do this, click the **"Open"** button to the right of **"YAML to import from"** and then browse your folders until you find the file.

3. Click the **"Import"** button. Now the deeplabcut module will run and extract as many frames from the video as defined in the config file. This might take a while. You can track the progress in the command line. Once it's finished, a message will pop up informing you that the import is finished.

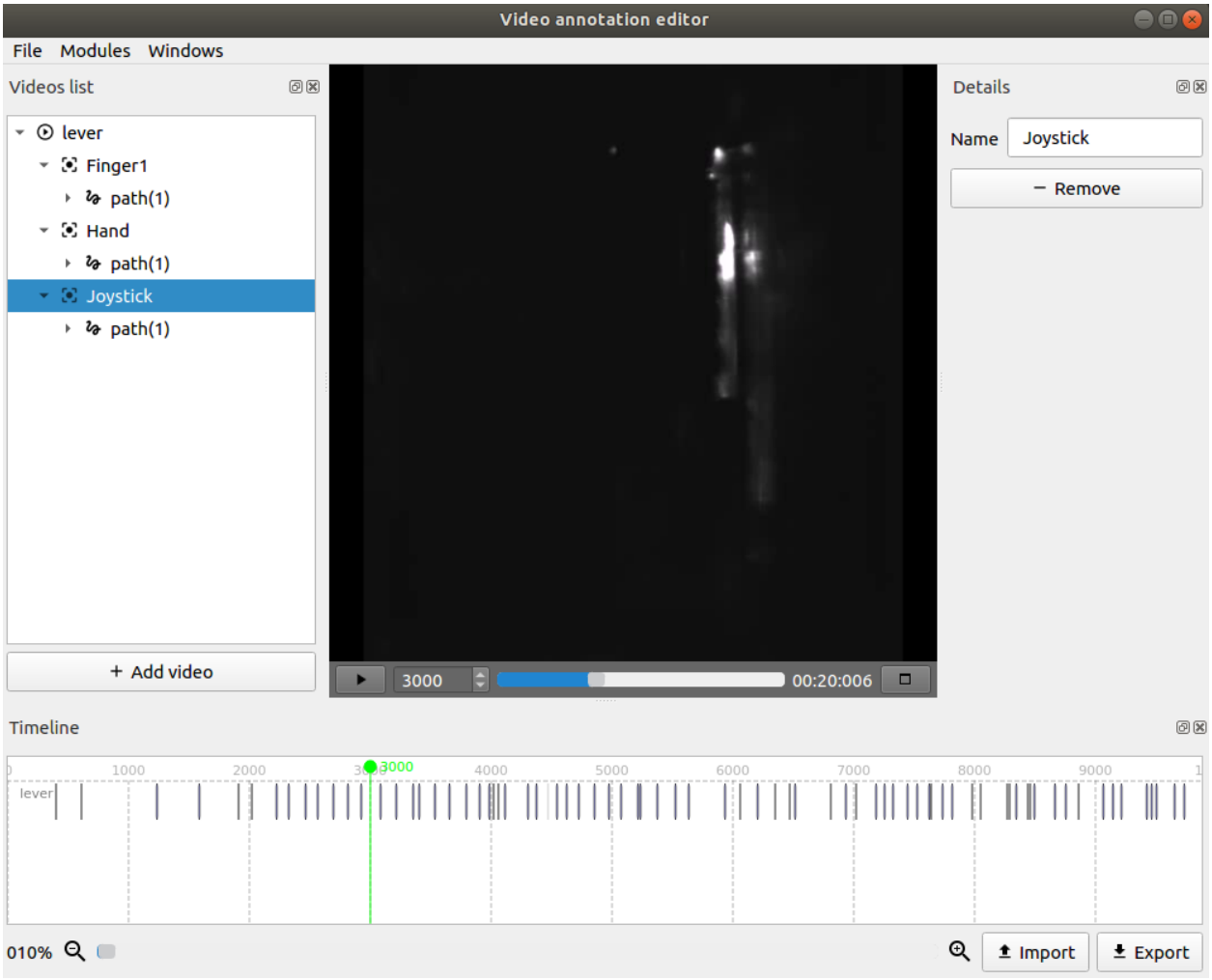
4. This step is done. Now move to the next step of *labeling the videos.*

8.4 Labeling the videos

Now you should have one or more videos created. Each video should have an object for each of the parts you want to label, and each part should have a path. Your timeline should also have a row for each one of the videos you're labeling.

Each frame you want to label is represented in the timeline as an event. It should look like a small vertical purple bar.

1. Select the row of the video you're about to label in the timeline. In most cases this should be the first row of the timeline. It should become highlighted in blue. Right now, your project should look like this:



2. Now you have to go through each frame, and for each object, select its path, then click the **"Mark Point"** button and then select its location with the **Left Mouse Button**.

You can do all of this using only the mouse, but to help you be more productive, there are a couple of very useful shortcuts:

- **U** - Selects the path of the next object and also clicks the **"Mark point"** button.
- **I** - Moves to the next event and also clicks the **"Mark point"** button.
- **O** - If a path is selected, clicks the **"Mark point"** button.
- **E** - Moves to the next event. If no event is selected, moves to the first event.
- **Q** - Moves to the previous event. If no event is selected, moves to the last event.

To quickly label, you should either:

- Label an object in all frames using the **I** shortcut
- Label all object in a frame using the **U** shortcut and then move to the next frame with the **E** shortcut

---

Note: You can select the color of each object's path, thereby changing the color of its "Mark point" marker on the right side. Simply click on **"Choose a color"** and then select the color you want.

---

3. To see if you maybe missed labeling one of the frames, you can do this:

1. Open the **"Modules"** tab and choose the **"Label DeepLabCut"** module.
2. Click the **"Check unlabeled frames"** button.
3. A text file will be created in your current directory. This text file tells you for each video and each part, what frames you still haven't labeled. If a part has no frames specified, then you have labeled that object in every frame.

4. Once you don't have any frames left to label, you can move to the next step of *exporting to a csv file.*

8.5 Exporting to a CSV file

1. Open the **"Modules"** tab and choose the **"Label DeepLabCut"** module.

2. Choose the directory you want the file to be written to. To do this, click the **"Open"** button to the right of **"Output directory"** and then browse your folders to select the one you want.

3. Choose the name you want for csv file. You simply have to write the name in the textbox to the right of **"Output file name"**. The **".csv"** extension will be automatically added to the end.

4. Click the **"Export"** button. The resulting csv file will now be in the directory you chose before.

5. You're done with the labeling of the videos. Now you can use deeplabcut to analyse the resulting csv file.

8.6 Result

The result will be a csv file for each labeled video. The csv file will look like this:

	A	B	C	D	E	F	G	H
1	scorer	manel	manel	manel	manel	manel	manel	
2	bodyparts	Hand	Hand	Finger1	Finger1	Joystick	Joystick	
3	coords	x	y	x	y	x	y	
4	labeled-data/lever/img2029.png	142	328	150	400	250	324	
5	labeled-data/lever/img4068.png	232	341	211	368	211	383	
6	labeled-data/lever/img6358.png	220	314	228	366	258	379	
7	labeled-data/lever/img7648.png	263	313	262	334	331	343	
8	labeled-data/lever/img7984.png	171	240	208	325	208	325	
9								
10								
11								

CHAPTER 9

Path map

This module maps the path of an object.

9.1 How to use

1. Open the **"Modules"** tab and choose the **"Path map"** module.

2. **Check** the corresponding checkboxes to select the **video**, the **object** and the **path/contour** for which you want to calculate a pathmap.

3. Use the **blue slider or the left and right textboxes** to **set a start and an end frame** for the calculation. The pathmap will only be calculated for the interval you choose.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

4. Use the **"Radius"** slider to set the radius size for the object. A bigger radius has a bigger impact in the pathmap. Try different sizes for the radius until you're happy with the resulting pathmap.

5. Press the **"Apply"** button and you're done.

9.2 Result

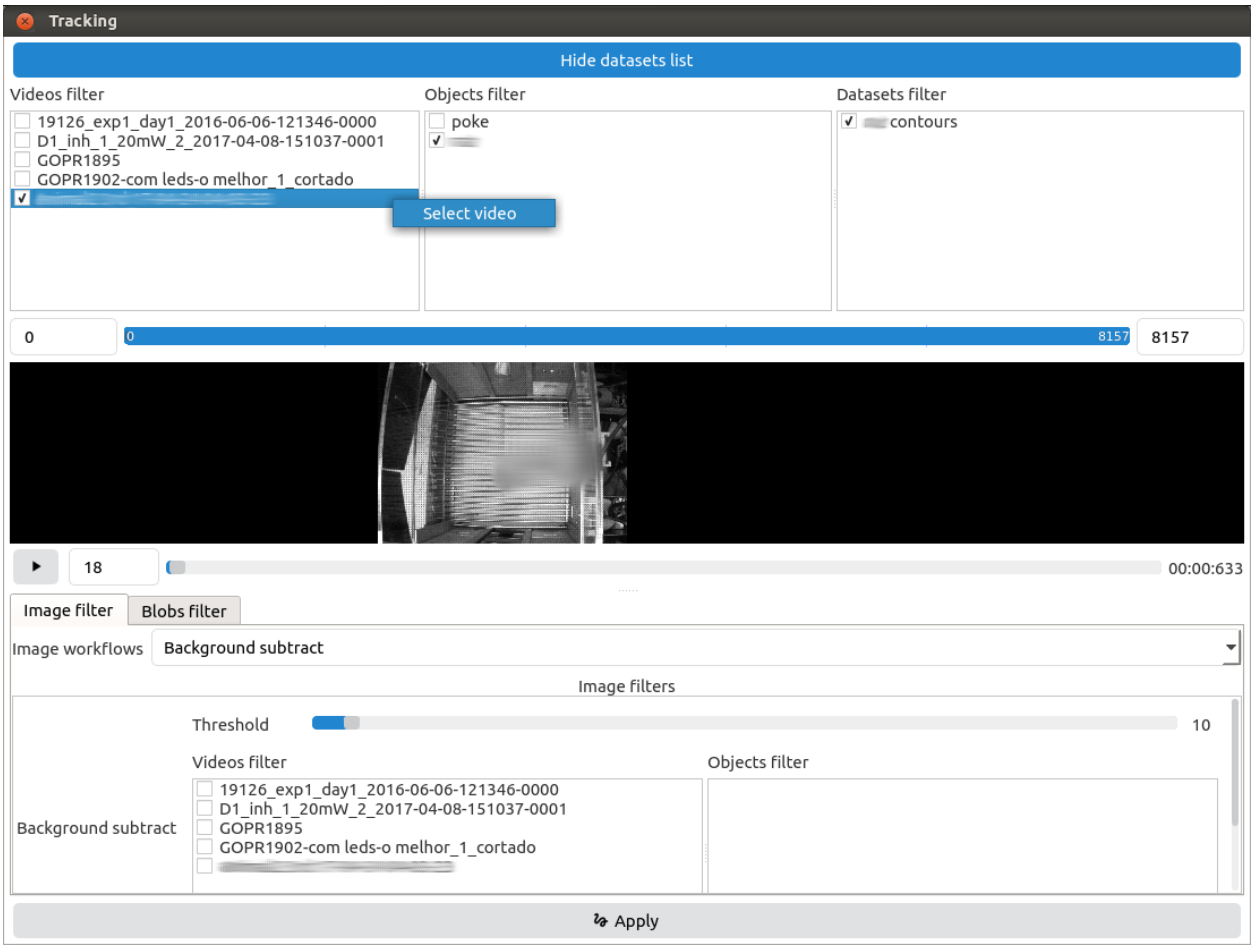
The calculated pathmap will be added to the video as a new image called **"pathmap-1"**.

9.3 Example

CHAPTER 10

Track objects

This module allows the use of simple tracking algorithms to track objects in a video.



10.1 How to use

To use the module the user has to go over 4 steps:

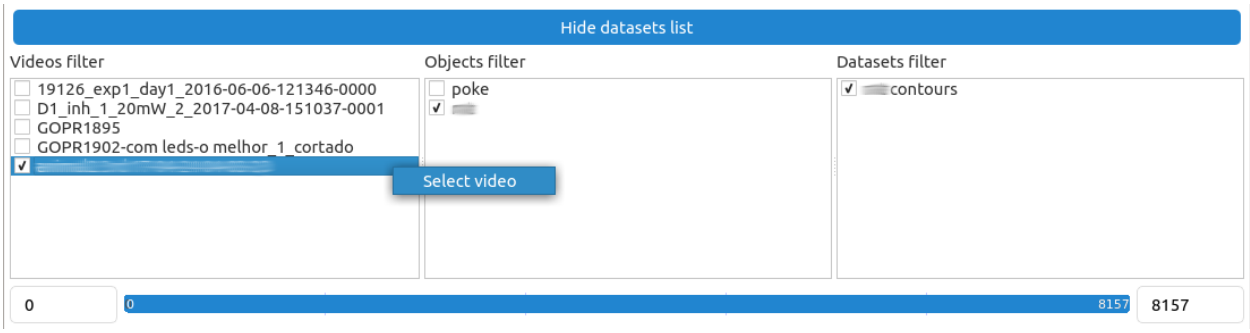
1. Choose the *datasets*.
2. Configure the image filters.
3. Configure the filters that should be applied to blobs resulted from the image filter.
4. Press the apply button.

10.1.1 1. Choose the datasets

Note: You can preview the motion calculation by clicking on the name of thevideo you selected and then clicking on the *'Play'* button under the video player

1. Add an **object** to the video, *here's how*.
2. Add a **path or contour** to the created objects, *here's how*.
3. Open the **"Modules"** tab and choose the **"Track objects"** module.

Now you need to define in which datasets the results should be saved. You should choose one dataset for each object you want to track, so if you have one object, you should choose one single dataset, if you have 2 objects to track you should choose 2 datasets.



4. On the top part select the video, the object and finally the object's **path or contour** to determine the object you will track.

Note:

- If the dataset is a path only the position's over time will be stored. If it is a contour you will save all the objects information over time.
- The analysis of multiple videos in one single execution is not working yet, please choose datasets of one single video.
- You can hide the datasets field by pressing the top button "Hide datasets list".
- To preview the video in the player, right click the name of the video and click **"Select video"**

5. Use the **blue slider or the left and right textboxes** to **set a start and an end frame** for the tracking. The tracking algorithm will only run for the interval you choose and the object's values will only be stored for this interval.

10.1.2 2. Configure the image filters

On this step the user configures the image filters that are going to be used to split the objects from the background image.

1. From the **"Image workflows"** dropdown list, choose the one you wish to use. You can read each workflows' description in the following table.

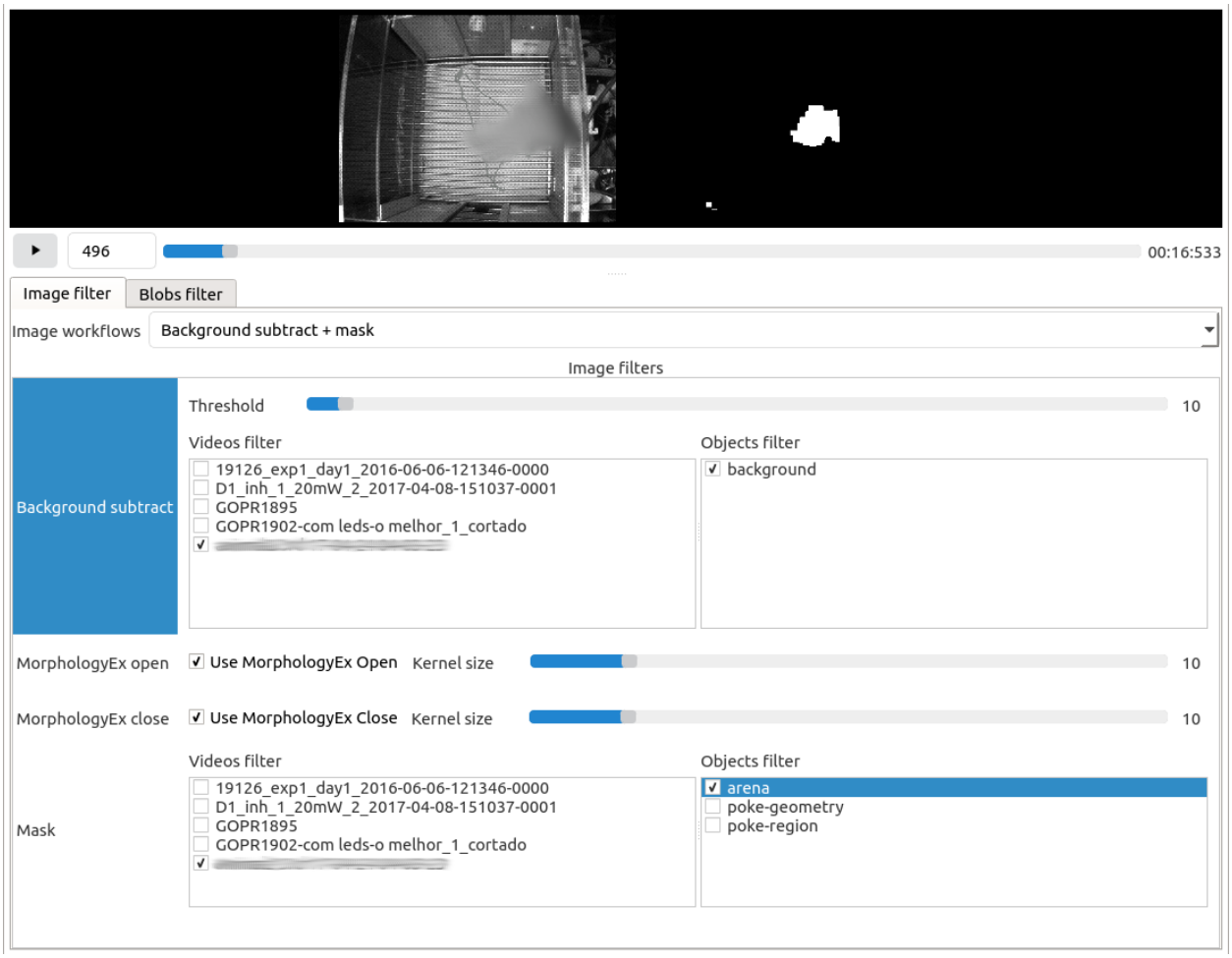
The current filters are:

Available filters	Description
Background subtract	An image is subtracted to the current frame.
Background subtract + mask	After the subtraction, a image mask defining a ROI is applied to the image.
Background subtract + path mask	After the subtraction, a circular mask around the current position of a path is applied to the image. Usually this filter is used to improve detail of contours found in previous analysis.
Background subtract + mask + path mask	It's a combination of the 2 previous filters.
Adaptative threshold	Applies an adaptative threshold to the image
Adaptative threshold + mask	After the threshold, a image mask defining a ROI is applied to the image.
Adaptative threshold + path mask	After the threshold, a circular mask around the current position of a path is applied to the image. Usually this filter is used to improve detail of contours found in previous analysis.
Adaptative threshold + mask + path mask	It's a combination of the 2 previous filters.

Note: For the **Background subtract** workflows you need to have an image in the project to use as background. You can *add one manually*, or use the module *Calculate the background image* to create one.

Note: For the **mask** workflows you need to have a geometry in the project to use as a mask. *Here's how to add a geometry to the project*.

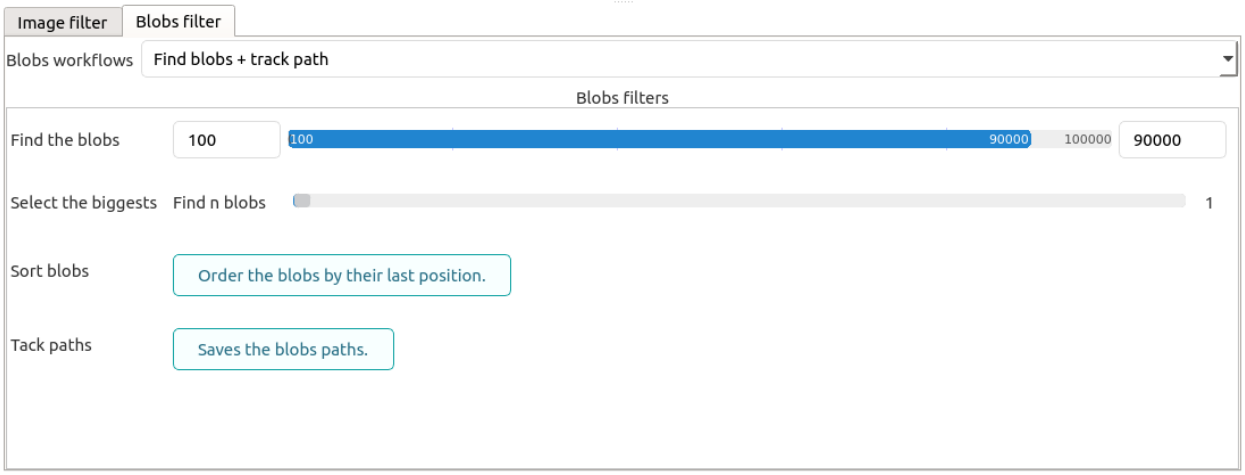
After selecting the workflow, the list of options available bellow will change. The options are parameters of the filters.The user can adjust these parameters and preview the result on the right side of the player as it is shown in image (white blob).



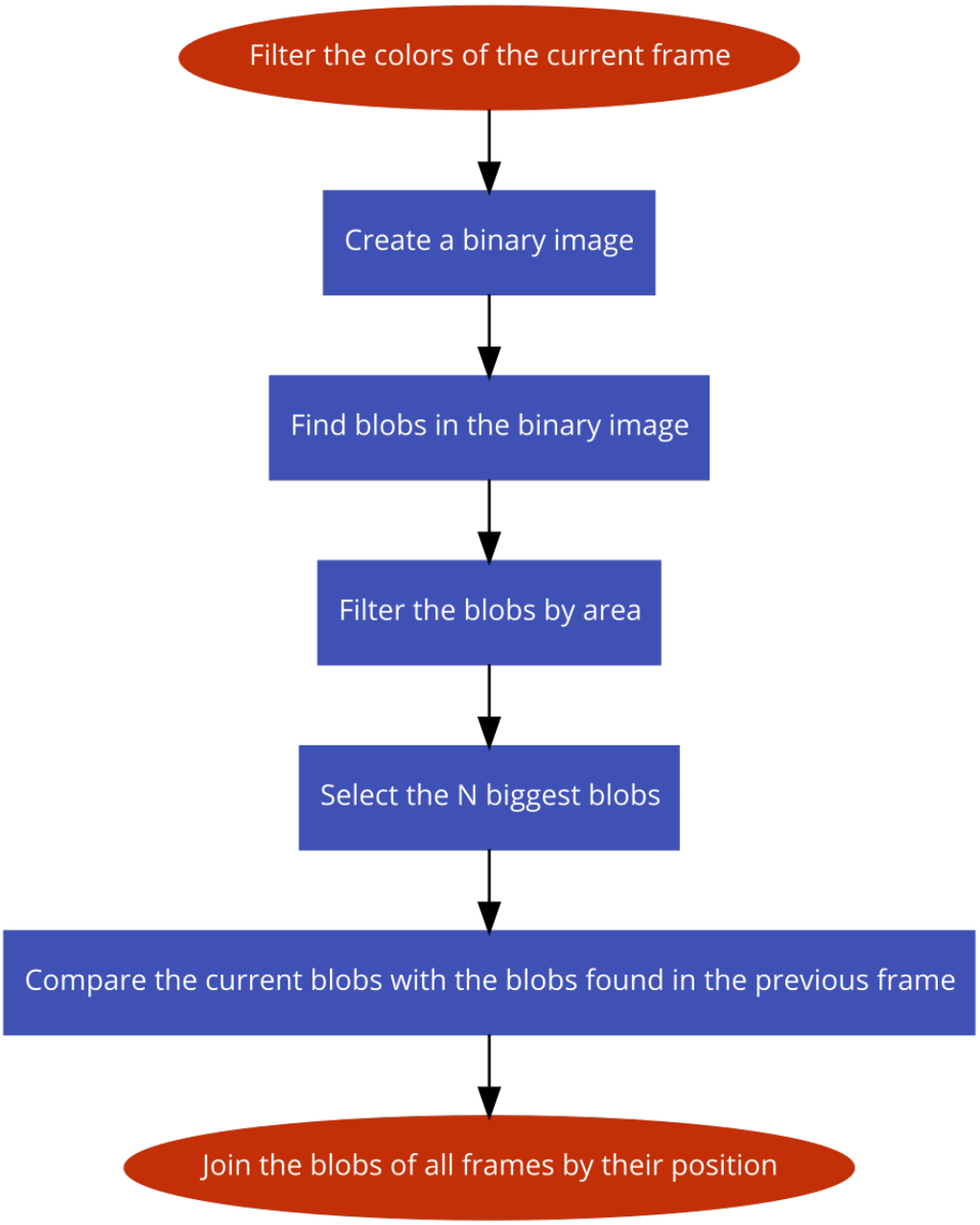
10.1.3 3. Configure the blobs filters

On this step the user configures the filters that are applied after step 2 workflow.

1. Click the **"Blobs filter"** button, on the left bottom part of the window
2. Choose as many blobs as the number of datasets you selected.



Schematic of the workflow of filters:



10.1.4 4. Apply and process

After you have configured all the workflows and you are happy with the preview, simply click the **"Apply"** button on the bottom of the window. The processing might take a while to finish.

10.2 Result

The results of the module will be the stored information in the datasets. In case you chose a path as the object's dataset, the path's properties such as position and velocity will now have information. If you chose a contour as the object's dataset, the contour's properties such as position, velocity, area and extreme points will now have information.

You will also be able to see the outline of an object's contour if select the name of the video and play the video in the main window video player.

10.3 Example

CHAPTER 11

Filter by regions

This module calculates the distance between an object and a geometry's closest border.

11.1 How to use

1. Create a geometry, *here's how*.

2. Open the **"Modules"** tab and choose the **"Filter by regions"** module.

3. On the top part select the video, then the object and finally the object's **path or contour** to determine the object used in the distance calculation. On the bottom part select the geometry you want to calculate the distance to.

4. Use the **blue slider or the left and right textboxes** to **set a start and an end frame** for the calculation. The distance will only be calculated for the interval you choose.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

5. Click the **"Apply"** button.

11.2 Result

After running the module, a value with the name **"regions-filter"** will appear under the object to which the path or contour belongs to.

If we plot this value into the timeline we can see the variation of the object's distance to the border of the selected geometry.

For the value of the calculated distance we have that:

- When the distance is **lower than 0** it means the object is **outside the geometry**.

- When the distance is **0** it means the position of the object is **over the geometry border**.

- When the distance is **higher than 0** it means the object is **inside the geometry**.

11.3 Example

CHAPTER 12

Extract the contour's images

This module generates images by extracting them from a contour.

12.1 How to use

1. Open the **"Modules"** tab and choose the **"Extract the contour's images"** module.

2. For each tab, choose the settings accordingly to how you want your images to be extracted:

12.1.1 Extract from contours

In this tab, **check** the corresponding checkboxes to select the **video**, the **object** and the object's **contour** you want to extract the images from.

Use the **blue slider or the left and right textboxes** to **set a start and an end frame**. The images will only be extracted for the frames in that interval.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

12.1.2 Mask

In this tab you can apply diferent masks to the image:

- to apply a simple mask check **"Apply a mask to the image"**
- to apply a dilated mask check **"Dilate the mask and apply it to the image"** and use the **"Dilate size"** slider to choose the dilation of the mask

- to apply a circular mask check **"Apply a circular mask to the image"** and use the **"Circular radius"** slider to choose the radius of the mask
- to apply the minimum ellipse of the contours as a mask to the image, check **"Apply the min. ellipse as a mask to the image"**
- to apply the minimum rectangle of the contours as a mask to the image, check **"Apply the min. rect as a mask to the image"**

12.1.3 Margin, image size and stretch image

In this tab you change the image size, strech the image and change its margins.

To change the image margins, use the **"Margin size"** slider.

To set the size of an image, use the **"Image size"** slider to set its size and then check **"Stretch image"** to stretch it. If you change the size of an image, you can also cut its height and/or width. To do this check **"Cut image"** and then use the blue sliders or the left and right textboxes to select the portion of the image that you want.

Note: The first slider changes the width and the second one changes the height of the image

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12.1.4 Rotate images

In this tab you can rotate the extracted images in different ways:

- if you want the contour in the extracted images to always be facing up, check **"Turn the contour always up"**
- if you want the contour in the extracted images to always be facing down, check **"Turn the contour always down"**
- to rotate all the images using a fixed angle, check **"Use a fixed orientation"** and use the **"Rotate the images using a fixed angle"** slider to set the angle
- to rotate the images using the orientation of another contour, check **"Use the orientation of other contour"** and then choose the other contour by first selecting the correspoding **video**, then the **object** and finally the **contour**

Note: You can only use one of these options at the same time

12.1.5 Center images

In this tab you can center the images.

If you want to center the images using another dataset, check **"Use a dataset to center the image"** and then select the dataset by first selecting the correspoding **video**, then the **object** and finally the dataset(path/contour).

12.1.6 Export images per events

In this tab you can organize the exported images by events:

- By checking an event, all the frames during that event will be exported to a folder with the event name.
- All the frames in which no event occurs or no event is selected will be exported to a folder named **"untagged"**.

Note: Click the **"Reload events"** button if you don't see any events in the **"Events"** tab

3. Choose the directory you want to save the generated images in by clicking the **"Open"** button on the bottom right side. A folder with the name of the video will be created in that directory.

Note: If you don't choose a directory, then a folder named **"contour-images"** will be created in your current directory.

4. Click the **"Apply"** button to generate the images.

12.2 Result

The result is a folder in the directory you chose with the name of your video. This folder contains all the images generated by the module. Navigate the folder to find the images, as they will be inside subfolders.

12.3 Example

CHAPTER 13

Calculate the video background

This module calculates the background image of the video.

13.1 How to use

1. Open the **"Modules"** tab and choose the **"Calculate the video background"** module.

2. On the left **check** the corresponding checkboxes to select the **video(s)** you want to calculate the background for.

3. On the right use the sliders to change the parameters of the background calculation:

    - **Gaussian blur matrix size** -> changes the size of the blur matrix
    - **Gaussian blur sigma X** -> changes the sigma X of the blur matrix
    - **Jump n frames** -> only does the algorithm described below every n frames
    - **Compare with frame in front** -> compares the current frame with the specified frame
    - **Threshold** -> uses the pixels over the threshold for the image

See the workflow of the algorithm to better understand what the parameters mean.

Note: **Lower values** for "Jump n frames", "Compare with frame in front" and "Threshold" will result in **more accurate** results

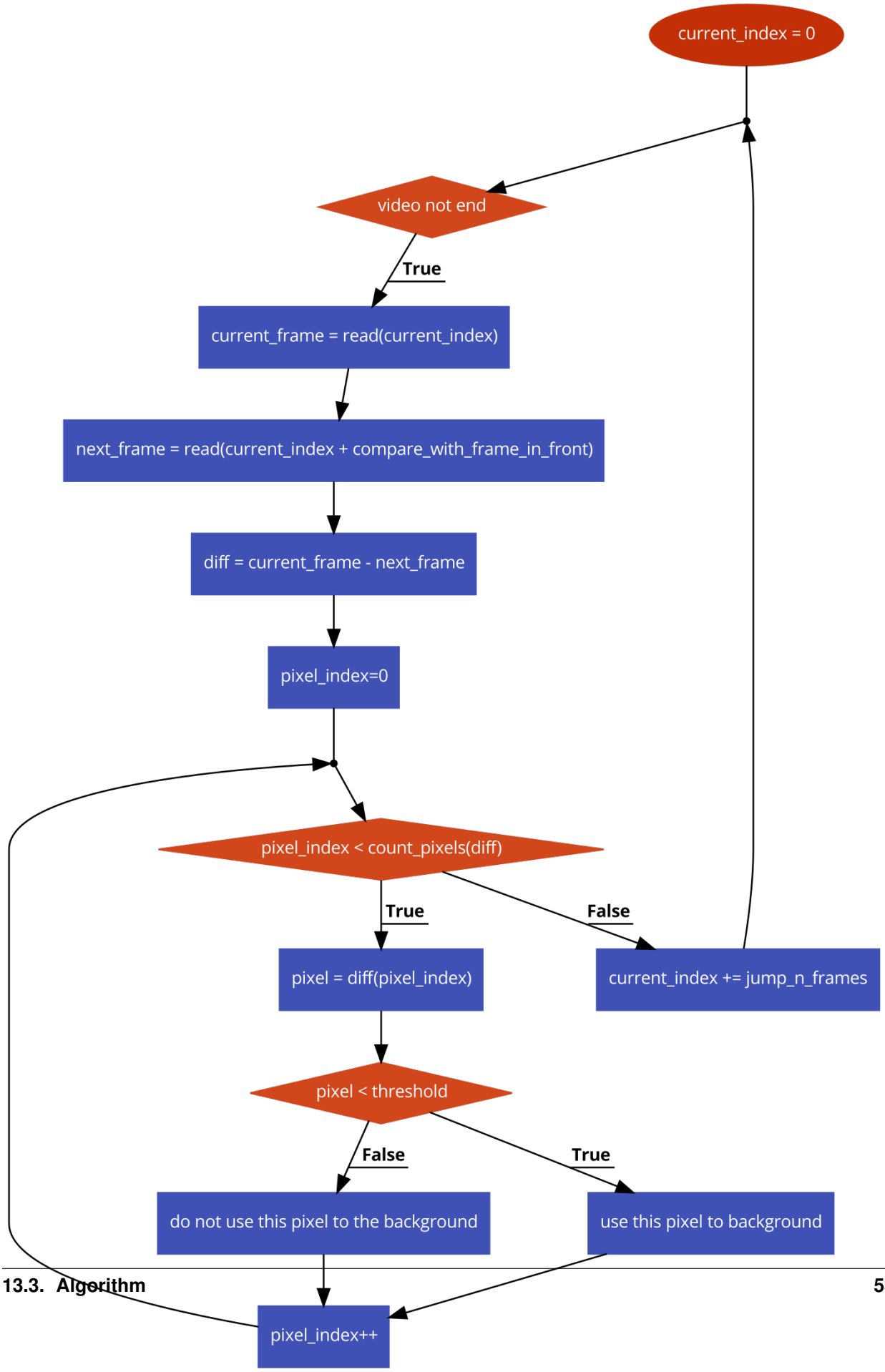
4. Press the **"Apply"** button to calculate the background image.

13.2 Result

The calculated background image will be added to the video as a new image called **"background-0"**.

13.3 Algorithm

The algorithm used to calculate the background is described in the next workflow:


current_index = 0
video not end
True
current_frame = read(current_index)
next_frame = read(current_index + compare_with_frame_in_front)
diff = current_frame - next_frame
pixel_index=0
pixel_index < count_pixels(diff)
True
False
pixel = diff(pixel_index)
current_index += jump_n_frames
pixel < threshold
False
True
do not use this pixel to the background
use this pixel to background
pixel_index++

13.4 Example

CHAPTER 14

Smooth

This module smoothens the data of a value or path using the Savitzky–Golay filter.

14.1 How to use

1. Open the **"Modules"** tab and choose the **"Smooth"** module.

2. If you want to smoothen the data of a value, first you have to create a value. See how you can create a value *here*.

3. **Check** the corresponding checkboxes to select the **video**, the **object** and the **path or value** for which you want to smoothen the data.

4. Use the **blue slider or the left and right textboxes** to **set a start and an end frame** for the calculation. The data will only be smoothed for the interval you choose.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

5. Use the **"Window size"** slider to set the Windows size parameter for the Savitzky–Golay filter.

6. Use the **"Order"** slider to set the Order parameter for the Savitzky–Golay filter.

7. Use the **"Derivative"** slider to set the Derivative parameter for the Savitzky–Golay filter.

8. Use the **"Rate"** slider to set the Rate parameter for the Savitzky–Golay filter.

Note: To obtain good results, the Window size parameter should be significantly bigger than the Order. You can read more about the Savitky-Golay filter here.

9. Press the **"Apply"** button and you're done.

14.2 Result

The value or the path used in the module will have its data automatically smoothed after running the module. To see the results you can *display the value/path on the timeline*.

14.3 Example

CHAPTER 15

Distances

This module calculates the distances between two objects, using their paths or contours.

15.1 How to use

1. Open the **"Modules"** tab and choose the **"Distances"** module.

2. **Check** the corresponding checkboxes to select the **video**, the **two objects** and the **paths/contours of the two objects** between which the distance will be calculated.

3. Use the **blue slider or the left and right textboxes** to **set a start and an end frame** for the calculation. The distance will only be calculated for the interval you choose.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

4. Press the **"Apply"** button and you're done.

15.2 Result

The calculated distance will appear under one of the two objects as a new value called: **"distance-between(...)".**

15.3 Example

CHAPTER 16

Motion

This module calculates the motion of an object, which means,the number of pixels that change from frame to frame for a path or contours.

16.1 How to use

1. Open the **"Modules"** tab and choose the **"Motion"** module.

2. On the top part select the video, the object and finally the object's **path or contour** to determine the object you will calculate the motion for.

Note: You can preview the motion calculation by clicking on the name of thevideo you selected and then clicking on the *'Play'* button under the video player

3. Use the blue slider or the left and right textboxes to **select a start and an end frame** for the calculation. The motion will then only be calculated for the specified interval.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

4. Use the **"Compare with"** selection box to choose how the motion is calculated:
   - **First frame** -> compares the current frame with the first frame
   - **Previous frame** -> compares the current frame with the previous frame (current frame - 1)

- **Background image** -> compares the current frame with a background image

To create a Background image you can either *capture a frame* or use the *"Calculate the video background"* module.

6. Use the **"Threshold"** slider to set the treshold for the motion

7. Use the **"Radius"** slider to select the radius the motion calculation

8. Check the **"Show diffs boxes"** if you want the preview to show the pixels that changed in the current frame

9. Press the **"Apply"** button to calculate the motion.

16.2 Result

The calculated motion will be added to the contours or path dataset as a new value called **"motion"**.

16.3 Example

CHAPTER 17

Estimate the countour's orientation

This module estimates the countour's orientation.

17.1 How to use

1. Open the **"Modules"** tab and choose the **"Estimate the contours orientation"** module.

2. On the top part select the video, then the object and finally the object's **contour** that you want to estimate the orientation for.

3. Use the **blue slider or the left and right textboxes** to **set a start and an end frame** for the estimation of the orientation. The orientation will then only be estimated for the interval you choose.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

4. Use the **"Minimum steps"** slider to set the minimum steps for the estimation

5. Use the **"Minimum distance"** slider to set the minimum distance for the estimation

6. If you want to see all the intermediate values of the estimation, check the **"Create all the intermediate values"** checkbox

7. Click the **"Apply"** button.

17.2 Result

The contour's value **"angle"** will be automatically updated after running the module. This angle is displayed in the video as the blue line showing the contour's orientation.

17.3 Example

CHAPTER 18

Export videos

This module allows the user to generate new videos with the annotations and the object's paths or contours directly drawn on the video.

18.1 How to use

1. Open the **"Modules"** tab and choose the **"Export Videos"** module.

Note: You can preview the generated video by clicking the video you selected and then clicking on the *'Play'* button under the video player

2. For each tab, choose the settings accordingly to what you want to include in the generated video:

18.1.1 Path

In this tab, the user should select the video over which the annotations and/or the paths will be drawn.

By checking the **"Draw paths"** checkbox, all the selected paths and contours will be drawn in the generated video.

Using the blue slider or the left and right textboxes, the user can also select a start and an end time for the video. The video will then only be generated for the interval between the start and end time.

Note: To change the start and end frame you also have to click on the name of the video, **not just the checkbox**

18.1.2 Circle

To use this tab, you must have selected a dataset(path or contour) in the PATH tab.

If a contour was selected in the previous tab, a circle will be drawn in the position of the object for the corresponding frame using the contour's area.

In case you select the checkbox **"Use a fixed size"**, which is mandatory if the selected dataset is a path, a circle with a fixed size will be drawn every frame over the object's position. Use the slider to change the size of the circle.

18.1.3 Circle color

If any dataset is selected, the drawn circle will use the color of this dataset for each frame. If instead the checkbox **"Use a fixed color"** is selected, the drawn circle will use the chosen color. To change the color, simply change the numbers, beware it is in the BGR format (0-255).

18.1.4 Background

If any image is selected, the video will be generated with the image in the background instead of the frames of the video.

18.1.5 Draw events

Select the events to be drawn in the exported video. If the **"Draw titles"** checkbox is select, the titles of the events will be also drawn.

18.1.6 Split files by events

In this tab, the user can select to only generate the video during certain moments.
If no events are selected, the whole video will be generated. If one or more events are selected, the video will only be generated during those events.
The generated video will also be split in multiple videos, where each video will correspond to one of the selected events.

3. Choose the directory you want to save the video in by clicking the **"Open"** button on the bottom right side and then write the name you want the video to have in the **"Output file name"** textbox.

4. Click the **"Export Video(s)"** button to generate the video.

18.2 Result

The module will generate a video or videos in the chosen directory.

18.3 Example

CHAPTER 19

Export data

This module allow the user to export data to custom csv files.

19.1 How to use

1. Open the **"Modules"** tab and choose the **"Export Data"** module.

2. For every value you want to export, navigate through the project tree, select that value and click the **"Add"** button on the top left. In the resulting csv file, a column will be generated for each value you add. To remove a value, simply select it on the right side and click the **"Remove"** button on the top.

3. If the **"Split files by events"** checkbox is selected, then the values will only be exported for the frames during those events.
If no events are selected, the values during the whole video will be exported. If one or more events are selected, only the values during those events will be exported.
The output file will also be split in multiple files, where each file will correspond to one of the selected events.

4. Choose the directory you want to save the csv file in by clicking the **"Open"** button on the bottom right side and then write the name you want the file to have in the **"Output file name"** textbox.

5. Click the **"Apply"** button to export the data to the output file.

Note: The first column of the csv file will always be the index of the frame the other columns correspond to

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19.2 Result

The module will create a csv file in the chosen directory.

19.3 Example

CHAPTER 20

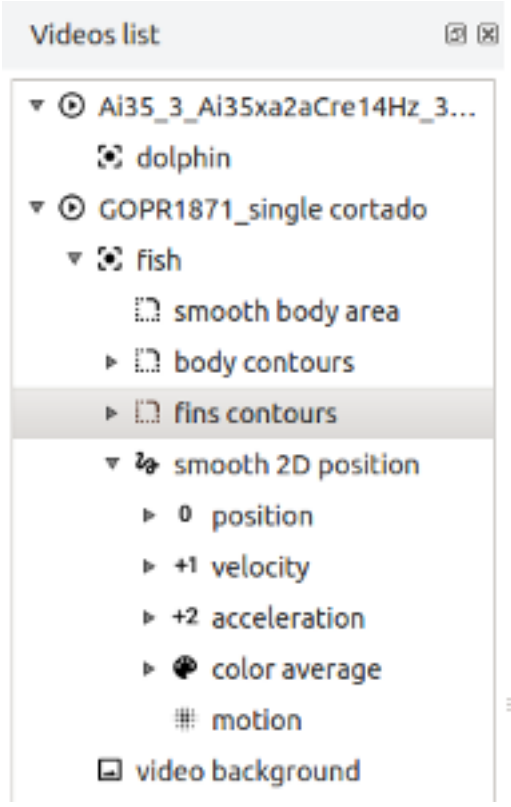
Project's tree

A project may have multiple videos and each video may contain several 2D objects associated to it.

The data is organized this way so the user will not get confused when analysing and comparing the outputs of multiple videos.

The structure has a hierarchy and is composed by Models (or Entities) (ex: a project is a model, a video is a model, and so on ...).

20.1 Hierarchy



A project is organized in the following hierarchy:

- **Project**
  - **Video**
    - Image
    - Geometry
    - **Object**
      - Path
      - Contours
      - Value

20.2 Models definition

Model	Description
Project	A project contains videos, and is the entity responsible for aggregating all the data in the application, including the graphs and annotations that are in the timeline.
Video	A video may have several objects or images associated to it.
Geometry	A geometry stores one or multiple polygons which define areas in the video.
Image	An image is just an entity to associate images to a video. For example if you use the module "Calculate the video background", you will create a background image under the corresponding video.
Object	An object is a 2D artifact present in the video. It can be used to annotate paths, motions or contours.
Path	Entity representing the path of an object.
Contour	Entity representing the contour of an object overtime. A contour contains a path also, but the diference between the Contour entity and the Path entity is that a contour path can't be smooth.
Value	A value is an entity that associates a generic value to an object. For example, you can create a value from a contour's area and smoothen this value to remove jittering.

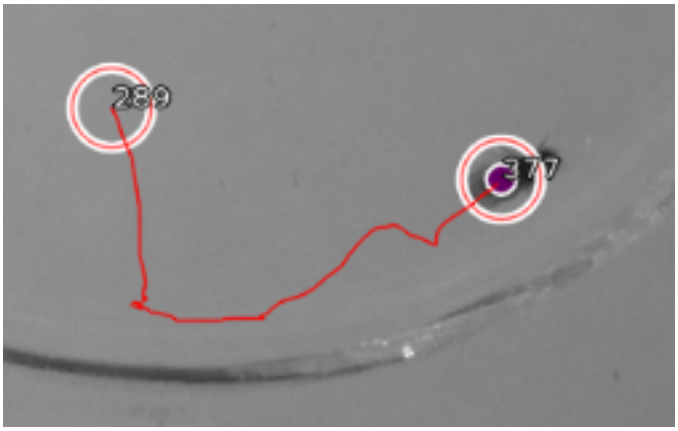
CHAPTER 21

Datasets

The datasets contain properties of an object. They are added to an object by some modules.

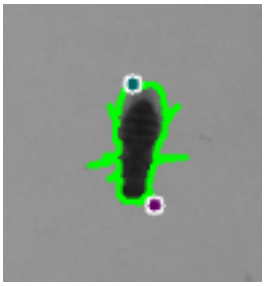
For example, the base properties of a path or a contour are added by the "Track objects" module. The color average property is added by the module "Extract the contours' images".

21.1 Path



Property	Sub-property	Description	Provided by the module
position			
	x	X coordinate	
	y	Y coordinate	
velocity			
	x	X velocity component	
	y	Y velocity component	
	absolute	sqrt(X*X+Y*Y)	
accelera-tion			
	x	X velocity component	
	y	Y velocity component	
	absolute	sqrt(X*X+Y*Y)	
color average			Extract the contours' images
	red	Average red color on a circle around each position of the path.	
	gree	Average green color on a circle around each position of the path.	
	blue	Average blue color on a circle around each position of the path.	
motion		Number of pixels changed on a circle around each position of the path.	Motion

21.2 Contours



Property	Sub-property	Description
position		
	x	X coordinate
	y	Y coordinate
velocity		

Table 21.1 – continued from pr

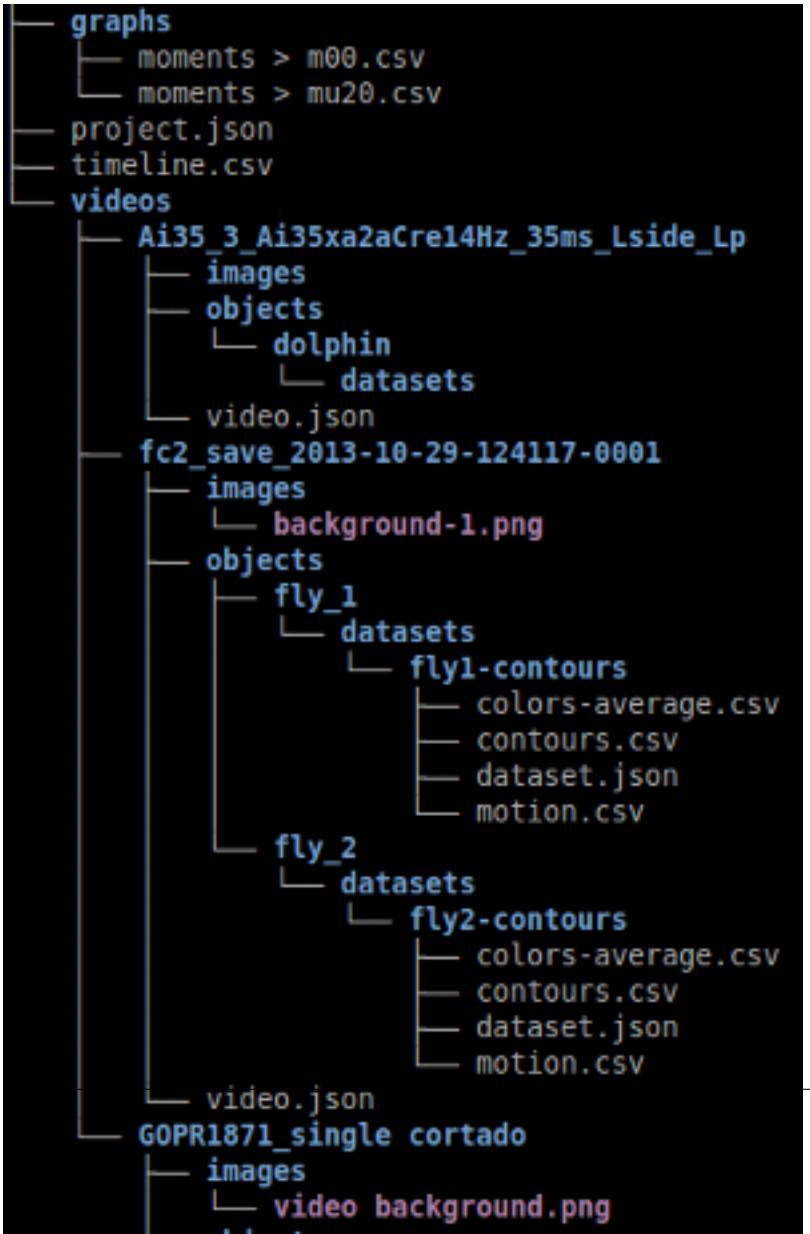
Property	Sub-property	Description
	x	X velocity component
	y	Y velocity component
	absolute	sqrt(X*X+Y*Y)
acceleration		
	x	X velocity component
	y	Y velocity component
	absolute	sqrt(X*X+Y*Y)
color average		
	red	Average red color on a circle around each position of
	gree	Average green color on a circle around each position
	blue	Average blue color on a circle around each position o
motion		Number of pixels changed on a circle around each pos
area		Contour area
perimeter		Contour perimeter
equivalent diameter		= sqrt(4*area/PI)
bounding rect		Result of the OpenCV function cv2.boundingRect
	left x	
	left y	
	width	
	height	
	aspect ratio	= (bounding rect > width) / (bounding rect > height)
	area	
	perimeter	= 2*(bounding rect > width) + 2*(bounding rect > hei
	equivalent diameter	= sqrt(4* (bounding rect > area) /PI)
	extend	= area / (bounding rect > area)
fit ellipse		result of the OpenCV function cv2.fitEllipse
	center x	
	center y	
	major axis size	
	minor axis size	
	angle	
extreme points		The 2 furthest points to the center
	p1	
	p1 > x	
	p1 > y	
	p2	
	p2 > x	
	p2 > y	
	angle	
convex hull		
	area	
	perimeter	
	equivalent diameter	= sqrt(4* (convex hull > area) /PI)
	solidity	= area / (convex hull > area)
rotated rectangle		result of the OpenCV function cv2.minAreaRect
	center x	
	center y	
	width	
	height	

Table 21.1 – continued from pr

Property	Sub-property	Description
	angle	
minimum enclosing circle		result of the OpenCV function cv2.minEnclosingCirc
	x	
	y	
	radius	
minimum enclosing triangle		result of the OpenCV function cv2.minEnclosingTria
	p1	
	p1 > x	
	p1 > y	
	p2	
	p2 > x	
	p2 > y	
	p3	
	p3 > x	
	p3 > y	
	perimeter	= dist(p1, p2) + dist(p2, p3) + dist(p3, p1)
moments		
	m00, ..., m03, mu20, ..., mu03, nu20, ..., nu03	All of the moments up to the third order of a polygon
hu moments		
	hu[0], ..., hu[7]	The seven Hu invariant given by the function cv2.HuM

CHAPTER 22

Project files



The structure of the project files is similar to that of the project's tree. The user can move the files around (always respecting the hierarchy) to define a new organization of the project.

22.1 timeline.csv file

This file stores the information about the events/notes in the timeline.

22.2 graphs folder

In the graphs folder you have several CSVs files, which correspond to the graphs visible in the timeline.

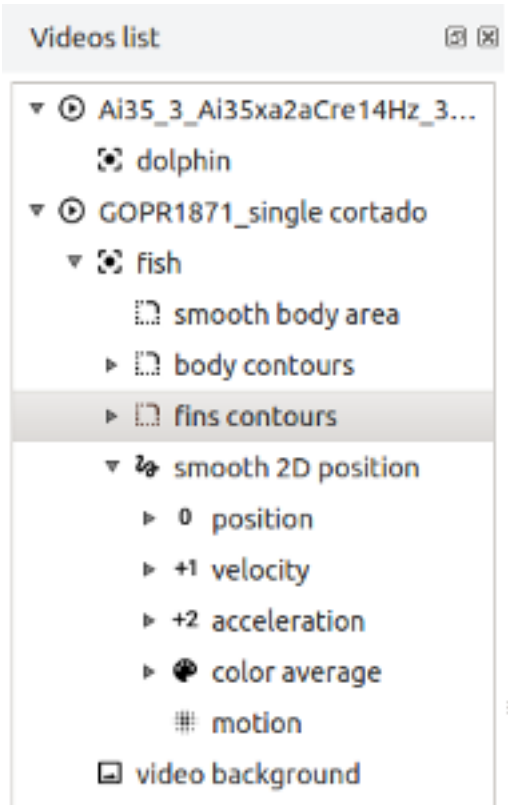
CHAPTER 23

Python Video Annotator's Documentation

23.1 What is the Python Video Annotator?

The **PythonVideoAnnotator** is a graphical application written in python, to analyse videos and create notes for events in the video. It was developed with the aim of helping neuroscience and ethology researchers indentify animals' behaviours based on the information extracted from the video.

Paths, contours and outputs of external devices, like accelerometers, sound recorders, pokes, pressure devices and other sensors can be combined to find classes of events to identify behaviours.



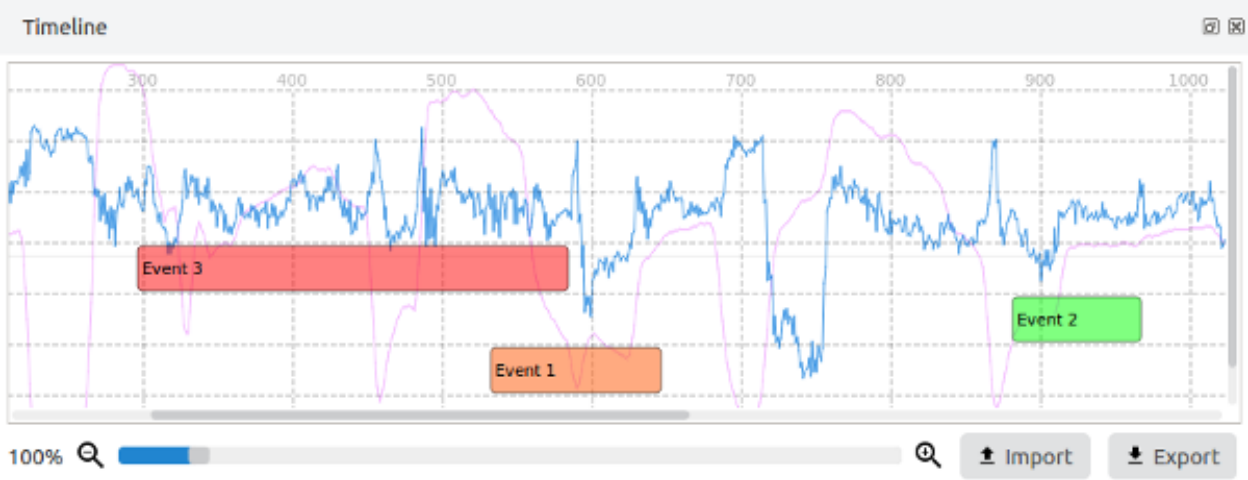
Organize your data and work on multiple videos at the same time with the project tree.

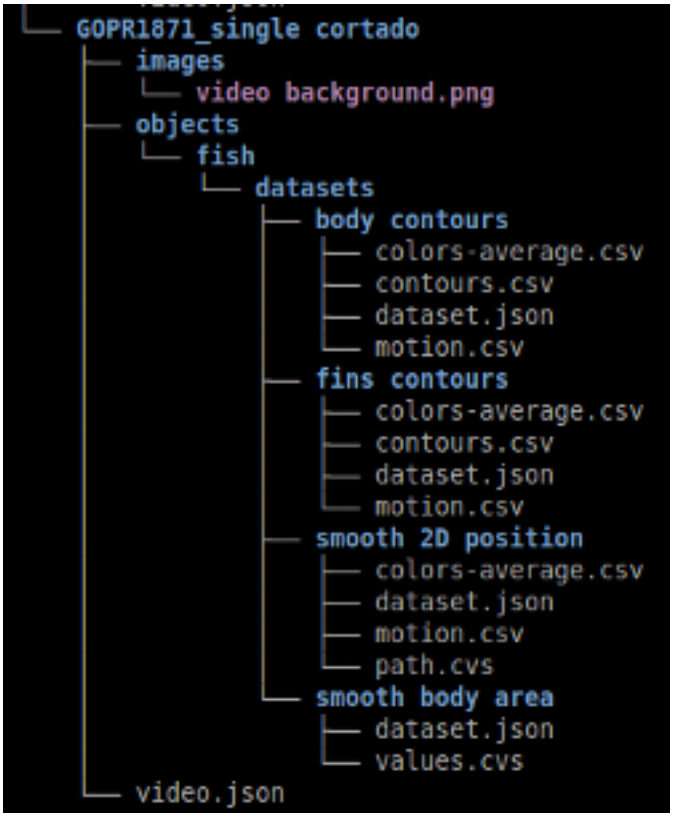
Import the output of your scripts, third party applications or external devices, into your project and follow its changes over the time.

On each video you may have associated objects that you can track and compare their properties.

Navigate in the video, annotate and modify events with the timeline bar.

Plot the data on the timeline to compare values over the time.





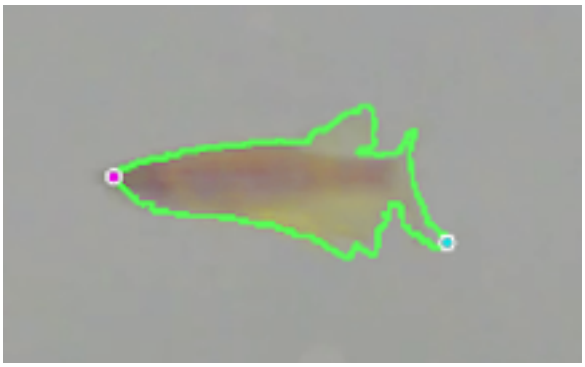
Access and modify the data easily with the open formats.

The project data is organized in an intuitive structure, and files are saved with open formats like json and csv to garantee the portability of the data.

Modify the project structure by moving the folders around with your filesystem manager.

The python video annotator is plugins based which allow to toggle the activation of the ones that are already included or add new ones developed by you.

Validate automatically tracking mistakes and correct them using the tracking modules or the manual correction.



Visualize the tracking information directly on the video player, smooth paths, calculate the videos' backgrounds and much more ...

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Thank you!!

23.3 Developers

Ricardo Ribeiro	**from the Champalimaud Scientific Software Platform** ricardo.ribeiro@research.fchampalimaud.org
Carlos Mão de Ferro	**from the Champalimaud Scientific Software Platform** carlos.maodeferro@research.fchampalimaud.org
Hugo Cachitas	**from the Innate Behavior Lab** hugo.cachitas@research.fchampalimaud.org
Manuel Manso	**from the Champalimaud Scientific Software Platform** manel.manso@research.fchampalimaud.org