

VideoTagger by Example: Overview and Case-Studies

Introduction

VideoTagger comes with many functions, which will be introduced in this document.

First, an overview of the functionalities of VideoTagger is given on the next page, which shows the function of all buttons and the standard navigation shortcuts.

In the following pages, we use three case studies to give an introduction to the range of uses for VideoTagger. Each of the case-studies focuses on a particular set of features of VideoTagger. We present each case-study on a separate page, which we divided into three sections as illustrated below.

Mouse Behaviour Study

We illustrate how the user would use bookmarks and ROI labels to annotate the behaviour of mice in a series of videos

Underwater Habitat Study

Given a video of more than 2 hours, the user annotates some frames for the presence or absence of fish in order to train a classifier to automatically annotate additional frames for the same labels. These are reviewed using the hierarchical annotation tool

Fly-Ageing Study

Demonstrates the usefulness of the *hierarchical view* to navigate through 3 months of footage. We also demonstrate the features of VideoTagger available for videos using a cropped target.

Structure of Case-Study Page

The diagram illustrates the structure of a case-study page for 'Underwater Habitat Study'. It is divided into three main sections: Features, Example Exercise, and Screenshots. The 'Features' section is highlighted in orange and contains a list of features: Full-Frame Annotations, Plugins, Machine Learning Plugins (General), and Machine Learning Plugins (Example on Right). The 'Example Exercise' section is highlighted in blue and contains a list of aims and steps: Aims, Realization, Annotate Full Frames, and Apply Plugin. The 'Screenshots' section is highlighted in grey and contains four screenshots: Adding Full-Frame Annotations, Review of Sparse Annotations, Applying Machine Learning Plugin, and Review of Plugin Output. The page title is 'Case-Study: Underwater Habitat Study' and the focus is 'Full-Frame Annotations, Machine Learning Plugins'. The 'Features' section explains the focus features in detail, and the 'Example Exercise' section provides a walk-through of an example exercise that uses the features introduced on the left to accomplish a typical use-case. The 'Screenshots' section shows screenshots of features introduced in the features section, with some screenshots having additional text giving more detail on how the function works.

Title

Focus:
List of features of VideoTagger the page focuses on

Features:
Explanation of focus features in detail.
For every feature that is triggered or toggled by clicking a button in VideoTagger, the button symbol is displayed next to the feature name.

Example Exercise:
Walk-through an example exercise that uses the features introduced on the left to accomplish a typical use-case.

Screenshots
Screenshots of features introduced in the features section.
We have highlighted the buttons used to enter the depicted state.
Some screenshots have additional text giving more detail on how the function works.

System Overview

Focus: Interface, Standard Shortcuts

Interface

The interface is divided into several key areas:

- "Head-Up-Display"**: A horizontal strip at the top showing a sequence of frames. The current frame is highlighted with a black border.
- Preview Windows**: Located above the main video frame, they show the content of the ROI in the previous and next frames.
- User ROI**: A yellow box on the main video frame, labeled "(Case-Study 1)".
- Toolbar**: Located at the bottom, it contains various icons for navigation and editing.

Key features and shortcuts are detailed below:

- Plugins** (Case-Study 2)
- Trajectory Mode** (Case-Study 3)
- Full Frame Annotations** (Case-Study 2)
- Bookmarks** (Case-Study 1)
- Toggle Timeline** (Case-Study 1)
- Hierarchical Visualization** (Case-Study 2&3)
- Change into edit mode** (Case-Study 1)
- Play**
- Get full resolution frame**
- Refresh interface**
- Shortcut settings**
- Save**

Shortcuts

Keyboard shortcuts for navigation:

- Navigate backwards**: F1 (-20x), F2 (-10x), F3 (-5x), F4 (-2x), F5 (-1x), F6 (-1x), F7 (1x), F8 (1x), F9 (2x), F10 (5x), F11 (10x), F12 (20x)
- Navigate forwards**: F9 (2x), F10 (5x), F11 (10x), F12 (20x)
- Frame Step**: F6 (-1x), F7 (1x)
- Escape**: Open Annotations, Close Dialog

Mouse actions:

- Re-Draw Annotation ROI**: Left button click
- Open/Close Annotation**: Middle button click
- Resize Annotation ROI**: Right button click

Getting Started

Installation, Quickstart

Installation

more detail on <http://peter.rennert.io/papers/videotager/install/>

Download and Install Anaconda

- Python distribution
- <https://www.continuum.io/downloads>

Install VideoTagger

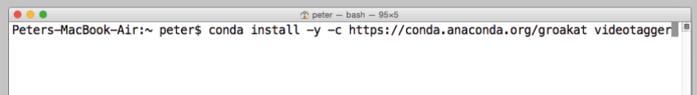
- 1 Open Anaconda command prompt in Windows (or any terminal in OSX and Linux)
- 2 copy and paste:

```
conda install -y -c https://conda.anaconda.org/groakat videotagger
```

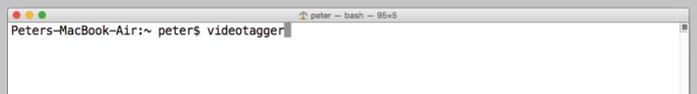
Start VideoTagger:

- 1 Open Anaconda command prompt in Windows (or any terminal in OSX and Linux)
- 2 type:

```
videotagger
```



```
Peters-MacBook-Air:~ peter$ conda install -y -c https://conda.anaconda.org/groakat videotagger
```



```
Peters-MacBook-Air:~ peter$ videotagger
```

Running VideoTagger

Quick Start (Single Video)

After opening VideoTagger the settings dialog opens (shown on right). To open a video file in VideoTagger

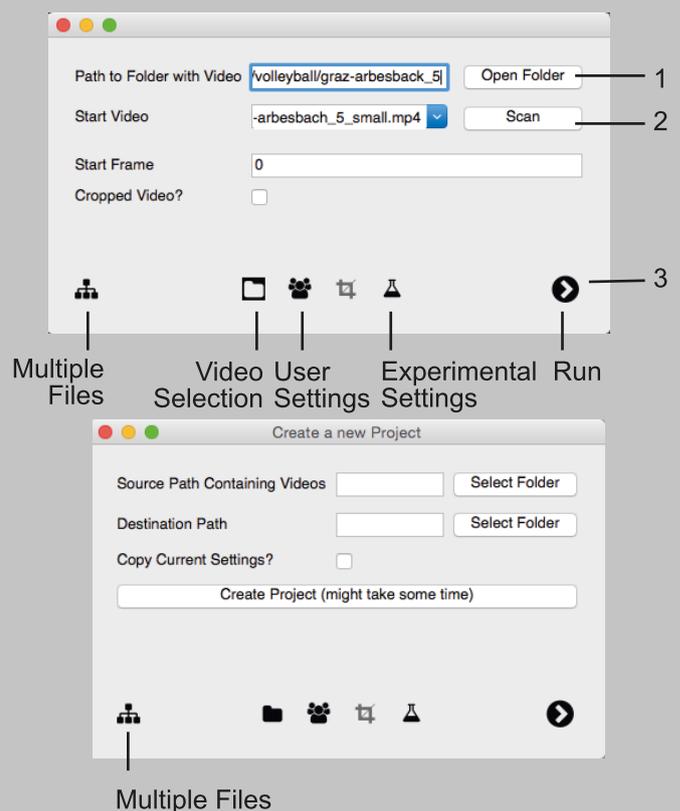
- 1 Open folder of the video file you want to open
- 2 Click on "Scan" to prepare the video file to be processed with VideoTagger
- 3 Click on the chevron ▶ to open the video

Working with Multiple Files

- Prepares all videos in a folder to be used with VideoTagger in a batch process
- Allows to pre-set all settings for all videos at once

Optional Settings

- Create project (see below) 🗑️
- User settings 👤
 - Username
 - Labels and their colors
- Advanced Settings 🔧



Case-Study 1: Mouse Behaviour Study

Focus: Bookmarks, Region of Interest Annotation

Features

Bookmarks 1

- Manually created bookmarks are saved automatically for each user separately into a file named {user}.bookmark.yaml
- By clicking on a bookmark, VideoTagger will jump the time-point in the video where the bookmark points to
- Bookmarks are saved in a plain text file (YAML structure). Which means they can be read and edited with simple scripts in any programming language, interpretable by the user when viewed in a text editor

ROI Annotations 2, 3

- Region of interest annotations take the form of bounding boxes that define spatial-temporal regions of interest
- Annotations are designated with a label provided by the user after being prompted by videotagger
- The bounding box can be drawn and resized using the mouse during the annotation.
- In edit mode  all features of bounding boxes can be revisited and edited at a later date
- Preview pane on top of the window show the content within the ROI in the previous and next frames. This feature helps to decide at which frames to begin and end an annotation.
- The timeline view  shows whether adjacent frames contain annotations.

Example Exercise

Aims

Annotate territorial behaviour of a resident mouse after an intruder is placed in a vivarium

User Actions

- 1 Create and use bookmarks to jump to interesting parts of the video (time when intruder is placed in the vivarium), to skip uninteresting parts in the beginning of the video
- 2 Annotate behaviour of both mice using the ROI tool

Creating Bookmarks Manually

- 1 Navigate to the moment the intruder was placed in the vivarium
- 2 Open bookmark pane  and click on **+**

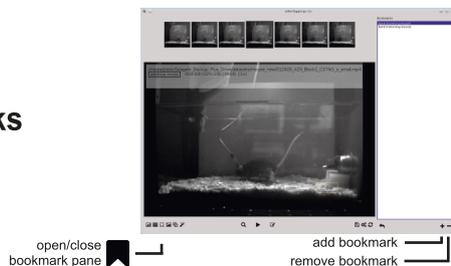
Navigating to Bookmark

- 1 Open bookmark pane 
- 2 Double click on an listed bookmark in the pane

Adding ROI Annotations

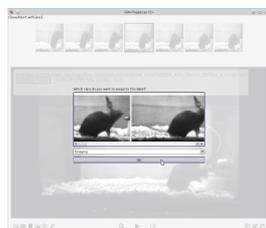
- 1 Navigate to the beginning of the animal action you want to annotate
 - 2 Left-click and hold to draw a region-of-interest (ROI) around the focal individual. This action will "open" an annotation. Release mouse button.
 - 3 Navigate forwards and backwards through the video using the keyboard shortcuts
 - 4 In each frame correct the ROI, options:
 - a Adjust the position of ROI by moving mouse
 - b Enlarge or shrink ROI using the mouse wheel
 - c Redraw the ROI as in 2
 - 5 Close annotation with right click. Label dialog will open, in which you can:
 - 6 Review annotation in dialog
 - 7 Enter annotation label in dialog and accept
- ! To abort at any of the steps above, press ESC

1 Using Bookmarks



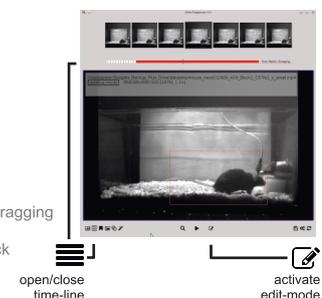
2 Add ROI Annotation

After closing annotation, image patches bound by the ROI can be reviewed before the user selects a class label



3 Edit ROI Annotation

In edit-mode:
Reshape the bounding box by dragging its corners or edges.
Rename and delete via right click



Case-Study 2: Underwater Habitat Study

Focus: Full-Frame Annotations, Machine Learning Plugins

Features

Full-Frame Annotations 1

- used to localize annotation in time only
- if full-frame annotations are present in the current frame, they are shown with coloured squares in the HUD (see screenshot 1)
- if the fullframe annotation pane  is opened, any annotation can be edited by left-clicking on the annotation name in the list

Plugins 3

- facility for automatic pre-processing of data, or application of machine learning pipeline

Machine Learning Plugins (General)

- Plugins allow VideoTagger to be adaptable to any task
- machine learning plugins extract feature data (descriptors) from the video and build a model (classifier) using user input
- this model can be applied to the entire video to replicate the users decisions and automate annotations
- Each specific task might need a specific pipeline to be effective.

Machine Learning Plugins (Example on Right)

The machine learning plugin used on the right comes with VideoTagger and implements the following pipeline:

- 1 extract a color histogram of each frame
 - the colour histogram picks up globally significant changes in the colour of the frame
 - Color histograms are appropriate to distinguish frames containing fish from the fairly stable "empty" frames of blue sea
- 2 Train random forest classifier on labelled data
- 3 Classify all frames using the trained classifier

Example Exercise

Aims

Reduce manual workload on evaluating the contents of an underwater survey, by using a plugin to find frames containing fish in unviewed footage.

Realization

- 1 Label some frames with and without fish
- 2 Apply machine learning plugin on these annotations

Annotate Full Frames

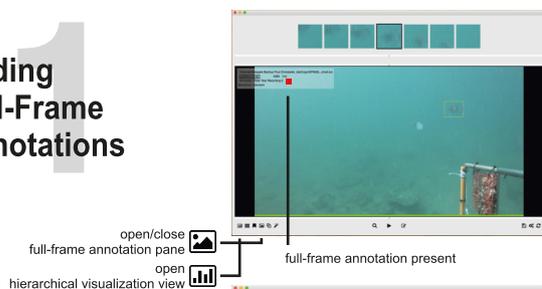
- 1 Activate the *full frame annotation feature* 
 - 2 Navigate to a frame
 - 3 Click twice on **+** to open an annotation for that frame and close it immediately
 - 4 Select either fish or no-fish as label
 - 5 Repeat steps 2-4 with frames throughout the video (every 10 min or so)
- ! You can use the *hierarchical view*  to visualize which frames you have already annotated and to navigate through the video by clicking on an annotation to that frame in the footage

Apply Plugin

- 1 Open plugin pane 
 - 2 Load a folder containing plugins with **+**
 - 3 Apply *SimpleHistogramPlugin* by pressing *start*
 - 4 Once the plugin is finished, visualize the classification in the *hierarchical view* , which you can also use for navigation
- ! Classifier annotations are saved in the same way as user annotations and can be edited manually
- ! To improve the classifier performance, annotate more frames, try to capture as much variety (types of fish, shades of water color, etc) as possible

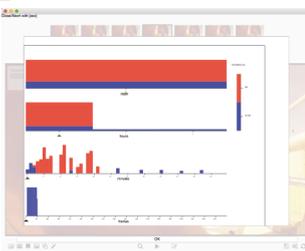
Screenshots

1 Adding Full-Frame Annotations

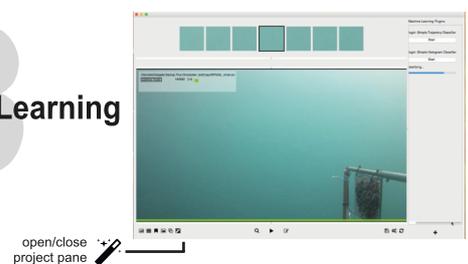


2 Review of Sparse Annotations

Note the visualization showing a few peaks only, indicating the few frames every few minutes were annotated. Red and green show that samples of both classes were annotated. See also next page for more details.

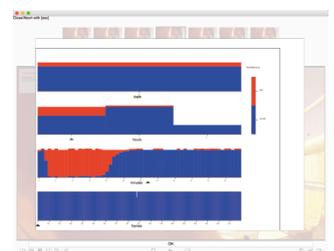


3 Applying Machine Learning Plugin



4 Review of Plugin Output

After the plugin ran through, the annotations are dense. This reveals that the presence of fish (red) is only seen at the beginning of the video.



Case-Study 3: Fly Ageing Study

Focus: Paste-In-Mode, Trajectory Visualization, File Concatenation, Hierarchical Visualization

Features

Paste-In Mode ¹

- some videos contain large amounts of unnecessary background that can be discarded if the object of interest is cropped out
- VideoTagger can read cropped frames and can paste them over a static background at the location given in a position file

Future Trajectory Visualization ²

- In the paste-in mode, the locations of the cropped patches are traced out in advance so that the user can react to upcoming changes in the footage
- This is particularly useful when the tracked object does not move for long periods of time

File Concatenation

- in multi-file mode VideoTagger will parse through a hierarchy of folders and concatenate individual video files (ordered by their order of filenames) into a single continuous stream of footage
- The videos will be seamlessly concatenated and appear as a single long video in VideoTagger

Interactive Hierarchical Annotation Visualization ³

- Activated with , see also ^{2,4} on previous page
- Manual annotations and outputs from plugins are visualized in hierarchical manner
- Allows a quick overview of annotation details for a month of continuous data
- The plot has four navigatable levels:
 - top level: each bar summarizes one day
 - 2nd level: each bar summarizes an hour
 - 3rd level: each bar summarizes a minute
 - 4th level: each bar summarizes 5 frames
- Clicking on any bar in rows 1-3 sets the focus of details of the levels beneath
- Clicking on a bar in the 4th level loads the corresponding frame in the VideoTagger

Example Exercise

Aims

Find age-related behavior in life-span of *D.Melanogaster* by analysing the 11th hour of each day in the life of the fly

Realization

- 1 Use paste-in mode and file concatenation to handle the approx. 130,000 one-minute videos that were recorded
- 2 Use trajectory visualization to use 60x fast forward speed when the fly rests
- 3 Use hierarchical view to show annotation result

Using Paste-In-Mode

- 1 Save video and position files in hierarchical folder structure, with filenames reflecting the position of the file in the global order
 - a It is recommended to use nested folders with folders for each day containing folders for the hours, which then contain the video files
 - b the video files and position files need to have the same filename apart from the extension
- 2 setup folder names in the cropped  part of the settings dialog

Use Trajectory Visualization

- 1 Toggle the trajectory visualization feature by clicking on 
- 2 As you navigate forward or backward through the video, the trail of boxes will indicate the future position of the fly

Review with Hierarchical View

- 1 Open the hierarchical view by clicking on 
- 2 browse the annotation results by clicking on the bars

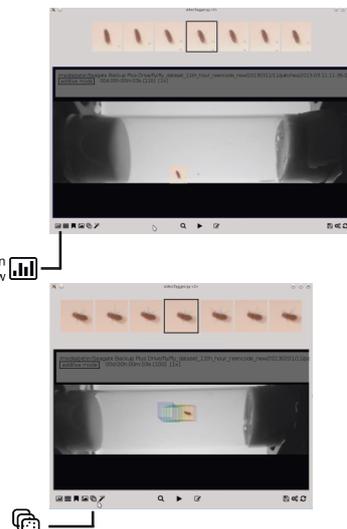
1 Using Paste-In Mode

Patch pasted in color,
Static background is shown in grey

open  hierarchical visualization view

2 Trajectory Visualization

Rainbow color-coding of future trajectory allows to see events approaching the current frame.



3 Hierarchical Visualization over 3 Months

Note the high-level trend in the day-section.
Only the 11th hour of each day is included in this visualization

