PYTHON ANNOTATION TOOL

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USER GUIDE

Annotation Tool V125

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INTRODUCTION

This guide presents the features and working of the annotation tool created by Erik Altermann for the DFG project on Human Activity Recognition (HAR) for Transfer Learning conducted at the Innovation lab of Technical University Dortmund, as a collaborative project between the Logistics and Pattern Recognition Department.

The annotation tool is intended to ease the process of window selection, class and attribute selection, during the annotation and revision process. Using this tool, one can load unlabelled ".cvs" files obtained from a motion capture (MoCap) system and play the video data contained in them. This further facilitates the annotator to split the frames based on the action sequences, playing the video forward and backward with varying speed, setting classes and attributes for intervals/windows in the video, merge/split frames, attaining neural network annotation predictions for further revision, etc.

The tool and the manual are prone to further modifications based on further research. For further updates, please follow:

Related paper: https://www.mdpi.com/1424-8220/20/15/4083

Tool: https://github.com/wilfer9008/Annotation_Tool_LARa

Guide: https://github.com/nilahnair/DFG-Project

SOFTWARE REQUIREMENTS

This application is based on Python version 3.7 or new. The following libraries are further required for its usage.

- pyqt5
- pyqtgraph
- pyopengl
- scipy
- pytorch
- scikit-learn
- numpy
- dill

Note: For first time users of Python and the toolset, a tutorial for installing Python is given here:
    https://github.com/nilahnair/DFG-Project/blob/main/Annotation%20Tool%20Installation%20Tutorial.docx
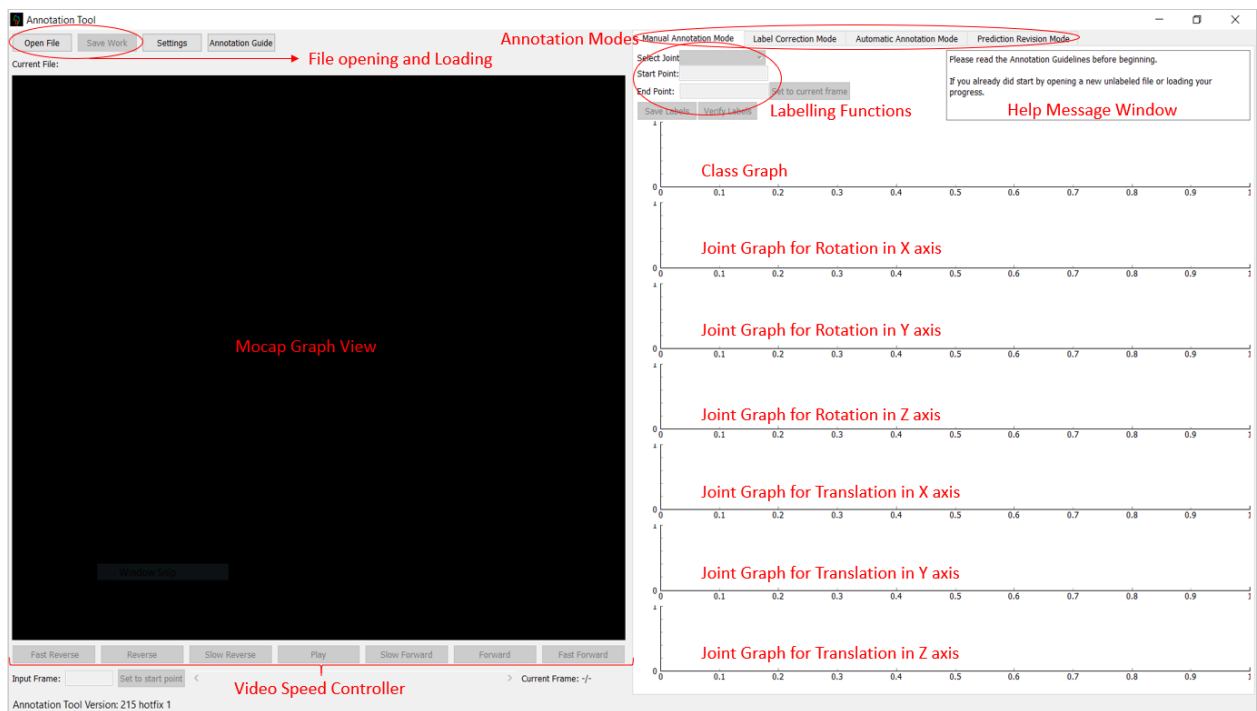
TOOL FEATURES

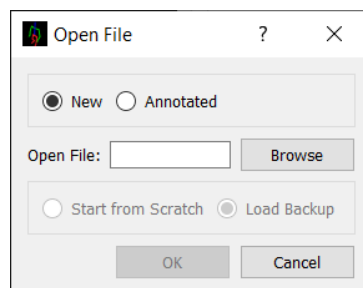*Figure 1: Annotation Tool*

File opening and loading

Figure 2: Open File pop-up

The "Open File" button can be used to load a the .csv file. Only one file can be loaded at a time. Clicking on the button opens the pop-up shown in Figure 2. "New" refers to .csv files which haven't been annotated previously. Option "Annotated" refers to files which have been previously annotated, such that when loaded, the class, frame and attributes can be viewed. The difference between a new file and an annotated file is the presence of labels, frames and window files alongside the data file. When viewed through the browse option, note that only the respective files' types will be made visible.

There are two further options: "Start from Scratch" and "Load Backup". These options are given to facilitate continuation of annotation on the same file in case of abrupt closure of the application. One can either use the back-up of the file, which was automatically stored in the "back-ups" folder of the Annotation tool file or start afresh.

Save Work

This option is only available after the verification of the annotated file. This button can be used to select the folder where you wish to save the annotated file along with the annotated identification number and annotation repetition number.

NOTE: For the purpose of verification, one always has to enter "Manual Mode" and click on "Verify Labels". Further, click on 'Save Work', once the message – "Labels are verified! You can save your labels. Please choose the folder for labelled sequences, when saving." - is received.

Settings

This pop-up has two tabs referring to "Video Settings" and "File Settings" as shown in Figure 3 and Figure 4. Under "Video Settings", one can set whether a floor grid on the MoCap Graph View is preferred or whether a Dynamic Floor is preferred. Dynamic floor refers to the movement of the floor grid based on the MoCap Skeleton figure's movement. When disabled, the Skeleton figure's gait will not impact the floor.

Further, the speed of the video can be set for slow forward/reverse, forward/reverse and fast forward/reverse. Here, the smaller the number you provide, the faster the movement of frames. As mentioned, 5 ms is the real recording speed. The application has been developed to support a speed of 1ms too.

The best practice is Fast Speed: 20, Normal Speed: 50 and Slow speed: 100. One can always change this based on their requirement and comfort.
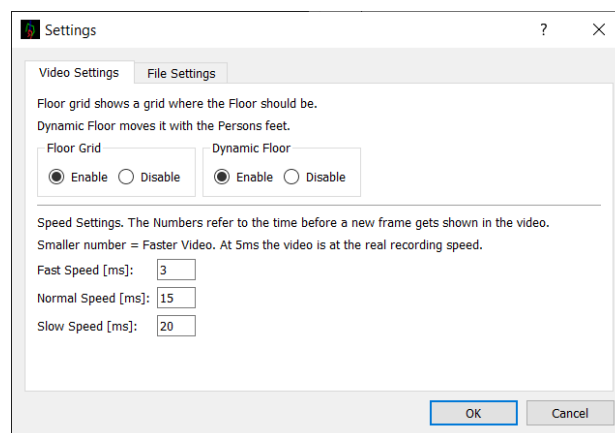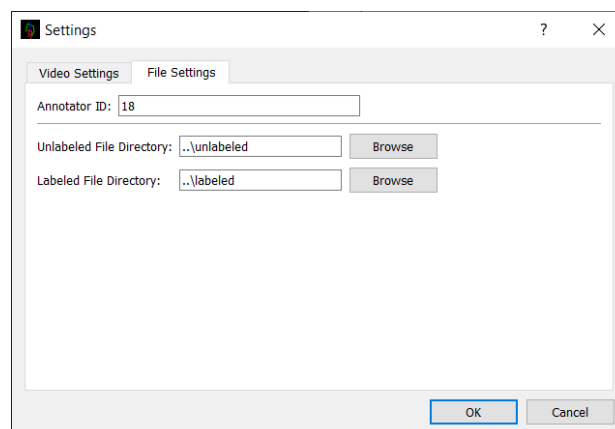

Figure 3: Settings pop-up – Video Settings

Figure 4: Setting pop-up - File settings

Under "File Settings" the Annotator ID can be set to a constant. Similarly, the location of the unlabelled and labelled file directories can also be set such that one needn't browse for the location every point of time.

Video Features

The video features include the MoCap Graph View and the video speed controller.

To rotate the view angle of the skeleton → left click and drag to the desired direction. Scroll to zoom in and out.

Use Settings → Video Settings to set or disable grid and dynamic floor.

Below the Mocap graph, are the video controls. One can Play/Pause the video and play it forwards or backwards in Fast, Normal or Slow speeds. Note that forward and backward will always have the same speed as set in 'Settings'.

The Scrollbar can be used to scroll to a different frame of the video.

Input the frame number you want to look at in the bottom left, 'Input Frame' box and press 'Enter' to go to the desired frame. Alternatively, the starting frame of a window can be entered into the box using the "Set to start point" button. This feature is meant to be used in the revision process under 'Label Correction Mode'. This may not work well for 'Manual Annotation Mode'. Here note that, the frame where the green cursor is present will be considered the frame of interest, Figure 5.
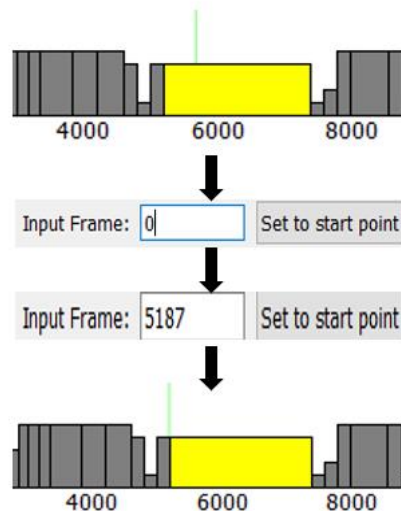

Figure 5: Input Frame Function

Joint Graph

Each one of the 22-point readings where a MoCap reflector has been placed on the subject to help form the skeleton figure, can be accessed by clicking on the "Select Joint"-Combo box and then choosing the preferred option.

Example: select "head" to see when the head moves in the RY graph, shows rotatory motion of the head during a handling process or so. Similarly, referring to the other joints can help in providing useful conclusions.

The joints available are: head, head end, L/R collar, L/R hemerus, L/R wrist, L/R elbow, L/R wrist end, root, lower back, L/R femur, L/R tibia, L/R foot, L/R toe.
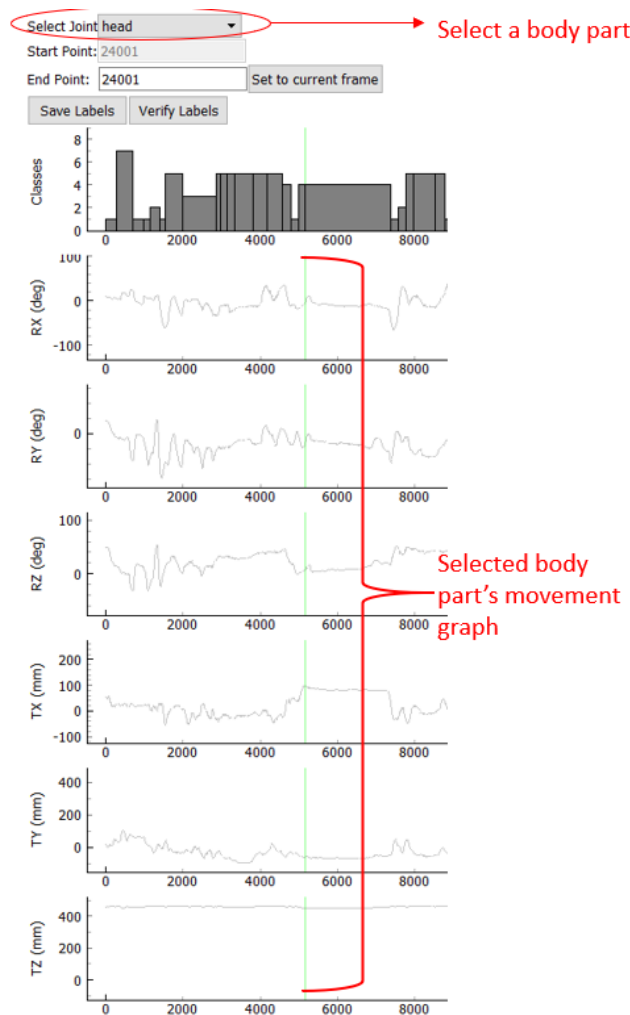

Figure 6: Joint Graph

Help Message Window

As shown in Figure 1, the Help Message Window tells the user the status, errors etc. Each annotation mode has its exclusive window, with errors, warning, and status message with respect to that mode. It is always ideal to keep an eye on this window why splitting, merging etc., to see its possibility or otherwise.

Class Graph

The class graph shows the entire range of the frames and the class assignment of the frames. Here, each class has a different height assignment, thus facilitating differentiation while annotation and revision. The classes can only be merged when the attributes match, else they are shown as a different window. When a particular window is selected it will be shown in yellow as shown in Figure 5.

Annotation Guide

Clicking on this button opens the web link of the guide.

MODES

There are currently 4 tabs for annotation modes. Manual Annotation Mode, Label Correction Mode, Automatic Annotation Mode and Prediction Revision Mode. The MoCap View Graph and settings aspect is common for all the modes. A similar feature is that, if and when a file needs to be verified before saving, one needs to shift from the respective mode to 'Manual Annotation Mode' and then click on 'Verify Labels' button.

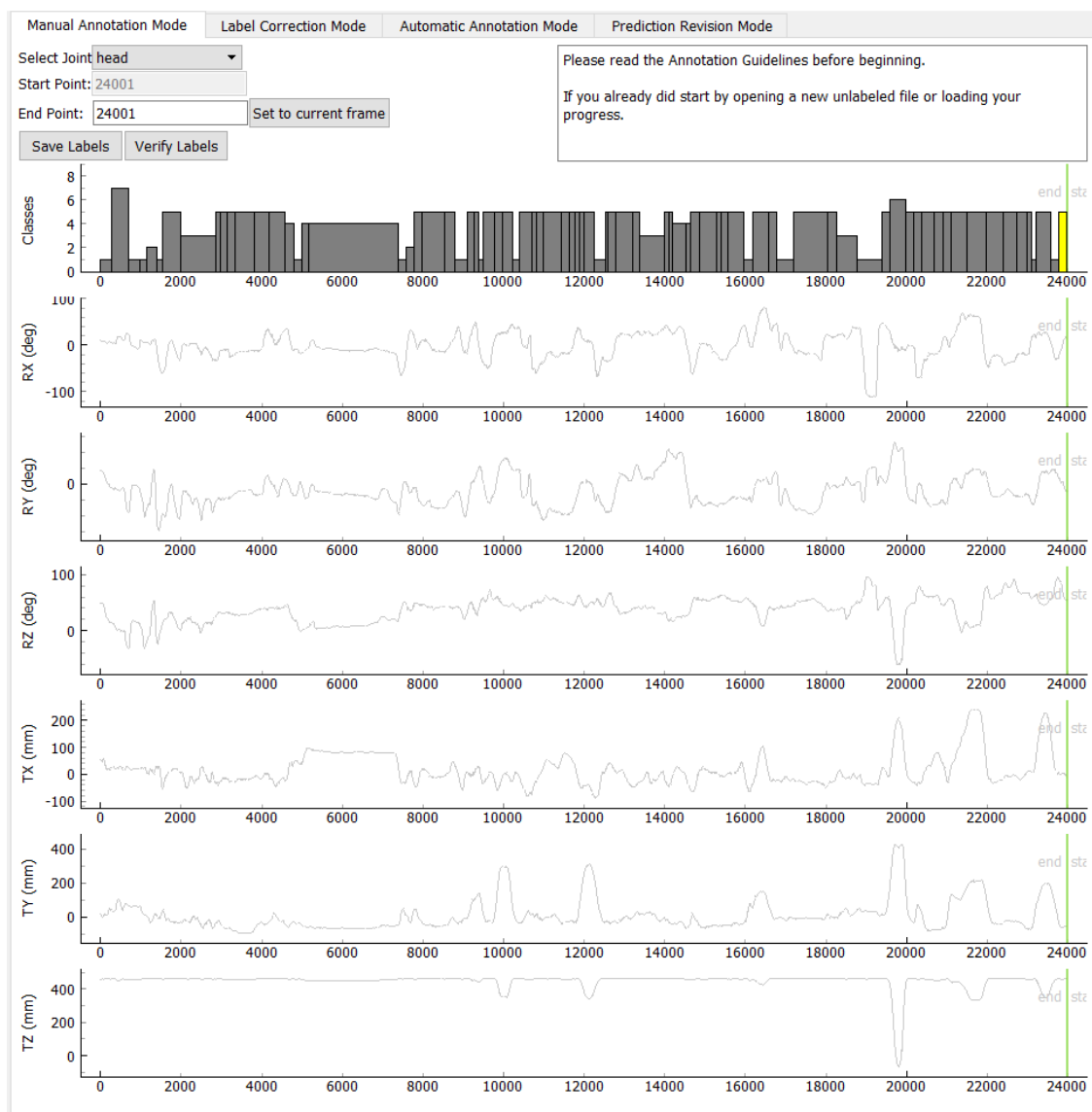Here, each modes' features have been explained in detail.

Manual Annotation Mode

Figure 7: Manual Annotation Mode

The manual annotation mode is focused on creating windows of a particular class and select attributes. This process is usually done on a newly obtained MoCap video. The annotator may see the MoCap Skeleton video and select the start frame and end frame of a particular action sequence and annotate the same with the class and attributes.

The start frame is set automatically and is always the starting frame from where annotation is not available. In the Figure 8: Manual Annotation ProcedureFigure 8, this point can be seen as the yellow line in the Classes graph. The green line refers to the end point, which is to be selected by the annotator. The frame number can be typed into the end point box or can be entered by stopping the video sequence at the desired frame and then clicking on "Set to current frame". This automatically enters the frame number where the green line is positioned at. To link the selected window to a particular class "Save Labels" button has to be pressed. This gives a pop-up where the classes and attributes have to be selected. The step-by-step procedure is given below.
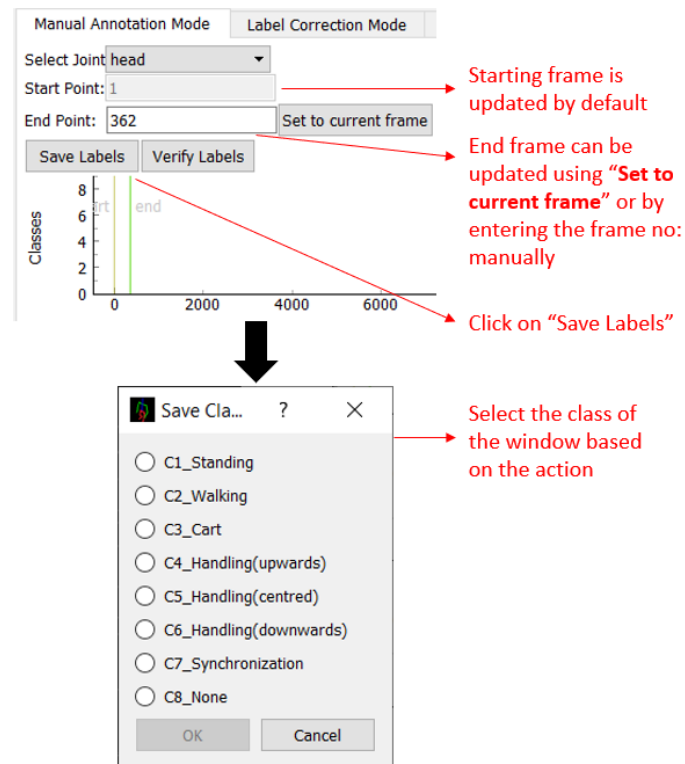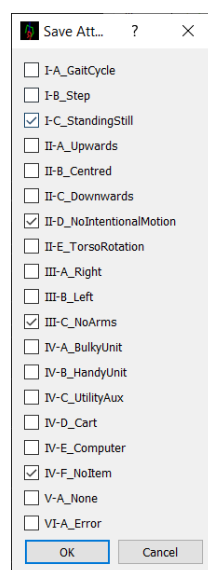

Figure 8: Manual Annotation Procedure

Figure 9: Save Attributes pop-up

Manual Annotation Procedure:

(1) Click on "Open File".
(2) Choose "New" and browse for files.
(3) We are assuming first time annotation here hence the "Start from scratch" option is expected by default.
(4) After loading the new file, make sure the green line shown in "Classes" graph is at Frame 1.
(5) Notice that the "Start Point" will have 1 by default and the yellow line and green line would be coinciding.
(6) Play the video and identify the first class of action.
(7) Stop the green frame at the end of the activity and enter the frame number either by
    i. Pressing the "Set to current frame" button or
    ii. Manually entering the frame number.
(8) Click on "Save Labels"
(9) Select the radio button of the appropriate class on the pop-up. Click on "OK".
(10) Select the attributes from the pop-up. Multiple attributes can be selected at a time. Click on "OK" to confirm selection.
(11) Repeat the process from step 6, till all the frames have been labelled.
(12) Click on "Verify Labels".
(13) Once verified, click on "Save Work".

As you can see in Figure 10, The "Start Point" value gets updated and the green and yellow line in the "Classes" graph are coinciding. Depending on the class type the grey bar will have varying height. Repeat the process from step 6 to step 10, till all the frames are duly labelled.

To save the work, first click on "Verify Labels", and when verification is complete, click on "Save Work". As mentioned previously give the annotation number, the number of trials and the location for saving the file.
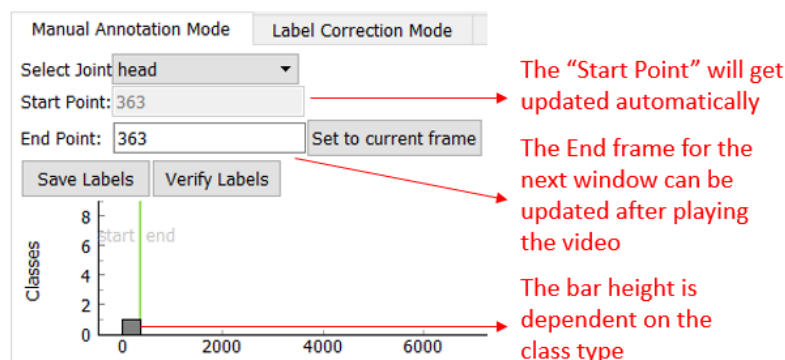

Figure 10: Labelled window

Label Correction Mode

Label Correction is part of the revision process. This tab can be used for revising both manually annotated as well as Neural Network generated annotation. Here, the revisor can split windows when they are of different classes or attributes, change the class and attributes of a window, re-allocate just few frames from a particular window to the previous window or the next window and merge all windows of the same class and attributes.

The revisor is ideally expected to view the entire video and make the required changes to the annotated data. Or they can also simply view a particular window and play the video and check the class and attributes, when the window has been marked in red to denote error attribute.

Figure 11: Label Correction Mode

Introducing the buttons available in the mode:

Merge with previous: This button can be used to merge the current window with the previous window, if they both have the same class and attributes. Even if one attribute is different, they cannot be merged.

Merge with next: If the current window has the same class and attributes as the next window, this button can be used to merge them. Even if they have the same class, but the attributes do not match, they cannot be merged.

Merge all adjacent equals: This button can be used to merge all the equal windows throughout the whole sequence, without individually checking the windows.

Split at: To split a window at a particular frame, this button has to be pressed. The frame where the split is desired can be manually entered or provided by using the "Set to current Frame" button, adjacent to it. Then click on the "Split at" button for finalising the splitting. This procedure can be seen in Figure 12. It should be noted that the selected frame, which is represented in yellow, will always go to the second half of the initial window. This can be a useful button, when the classes and attributes do not match with all the activities within a particular window.

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Move Start to: This button can be used when it has been brought to notice that, the frames that might have been well suited for the previous window are included in the current window. The transitional frame number has to be either manually entered into the box next to "Move Start to" button or by using the "Set to current Frame" button, provided the frame is positioned accurately. Click on "Move Start to" to make the change. The change can be seen in Figure 13. It can be noted that the initially active window size simply reduces but there is no change in the active window selection.

Move End to: This button functions similar to that of "Move Start to" button. This button is best used when the frames at the end of a particular window is best suited with the next window. The transitional frame number has to be either manually entered into the box next to "Move End to" button or by using the "Set to current Frame" button, provided the frame is positioned accurately. Click on "Move End to" to make the change. Note that similar to "Move Start to" button functionality, the initial window, which is of interest, remains active after the change. Only the width would be reduced.
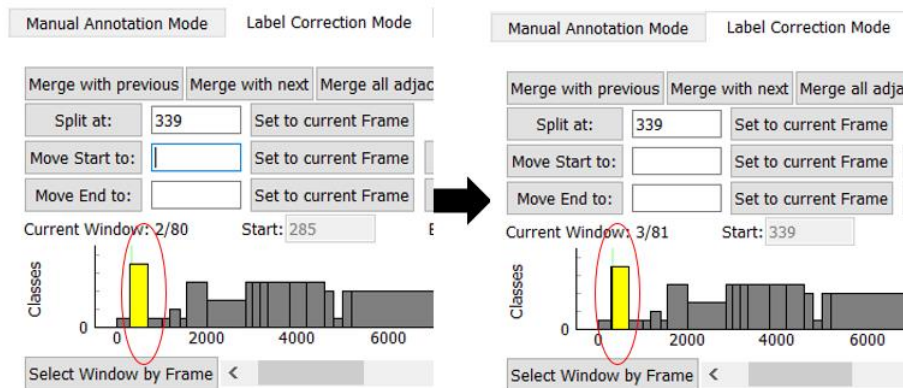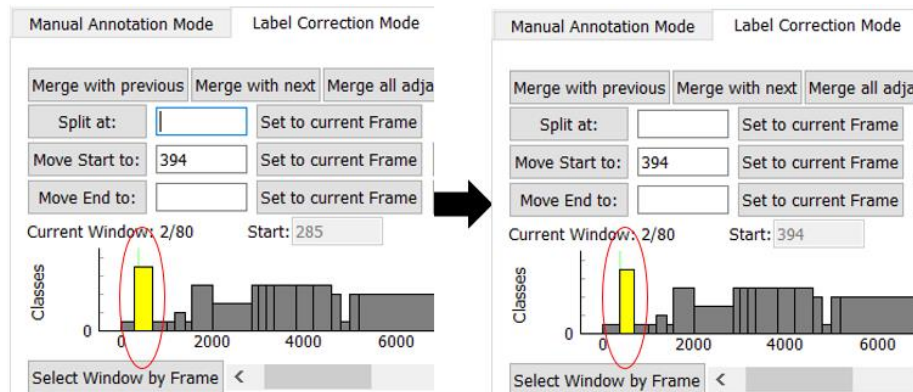

Figure 12: Split at

Figure 13:Move Start to

Set to Start: This button can be used to enter the selected window's starting frame number into the box next to "Move Start to".

Set to End: This button can be used to enter the selected window's end frame number into the box next to "Move End to".
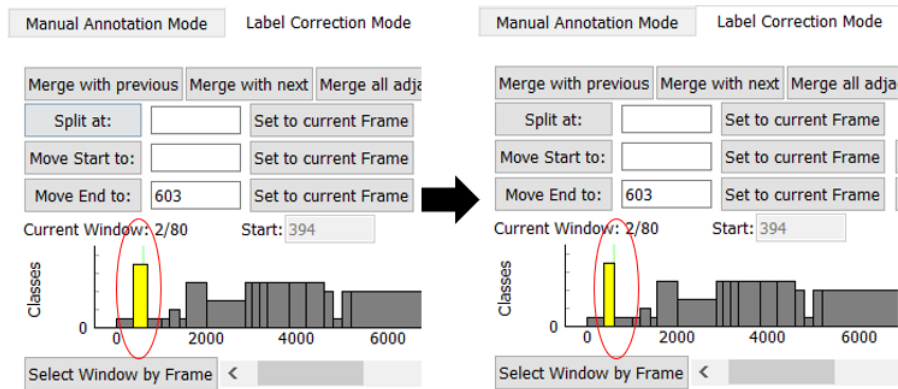
Figure 14: Move End to

Select Window by Frame: It is possible to scroll to a different window, while maintaining the green line, which refers to the current frame at a different window. The classes and attributes that's shown below the scroll always refers to the active window, shown in yellow. In case of wanting to return to the window where the frame is at, one can click on "Select Window by Frame" to swiftly move to that window.

The classes and attributes of the selected window, (shown in yellow) can be changed by choosing from the classes or attributes option. It is to be noted that since only one class can be chosen at a time, you only have to select the right choice from the options given on the right. In the case of Attributes, since multiple choices are possible, you have to unselect an option on the left to remove that attribute and click on the options on the right to select a particular attribute.

Note: In order to load an annotated file, choose "Annotated" option in the pop-up of "Open File".
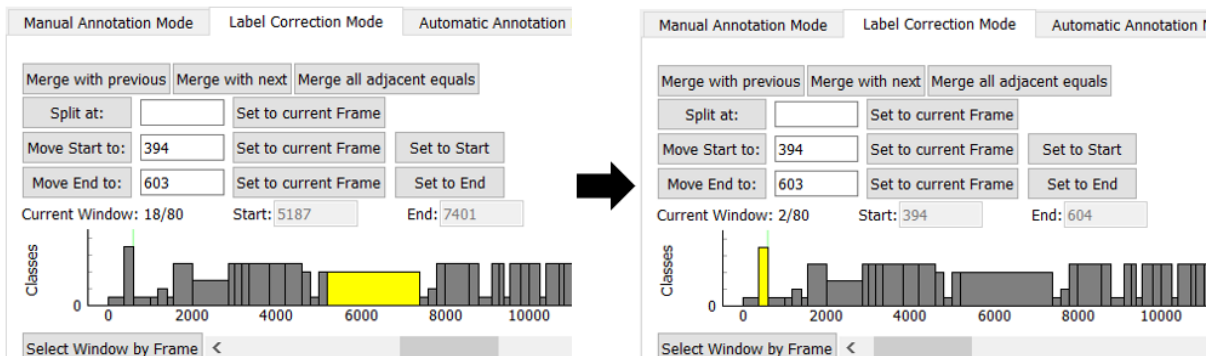

Figure 15: Select Window by Frame

After having completed the revision, change to "Manual Annotation Mode" to save the work. Click on "Verify Labels", and when verification is complete, click on "Save Work". Give the annotation number, the number of trials and the location for saving the file.

Figure 16: Classes and Attributes
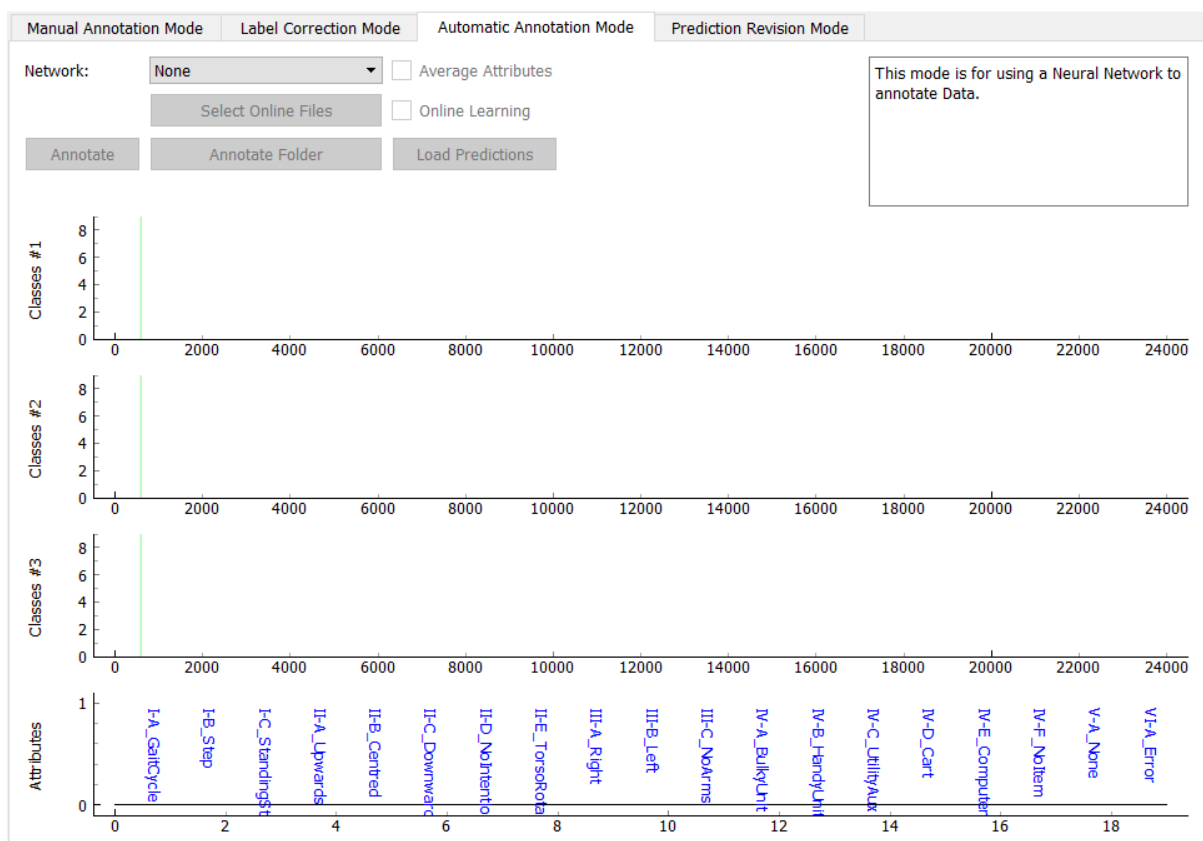
Automatic Annotation Mode

Figure 17: Automatic Annotation Mode

Automatic annotation mode is used for annotating the data with the help of a neural network. It can be of different kinds such as Class Network, Attributes Network, CNN IMU Network and CNN IMU Network retrained. More options can be included based on the type of network one wishes to test. The pt file type for the respective type of

network needs to be manually added to the "network" folder, placed alongside backups and src folders.

When the network selected is CNN IMU Network – Retrained, one only needs to click on "Annotate" button. This opens a Dialog pop-up which shows the step-in process such as loading network, annotating and evaluating as well as the percentage of process completion. Once the annotation is complete, the time taken by the annotation process can be seen on the "Help Message Window". The final result would look like Figure 18. The latest annotation run duration will be the last one to appear. In case an automatic annotation was previously performed on the same dataset, one can load the previously generated predictions by clicking on "Load Predictions"

In the case of Online annotation, the process is bit more involved and is shown step by step below:

1) Choose the file which you wish to annotate using "Open File" button.
2) Choose CNN IMU Network as Network.
3) Make sure "Average Attributes" check-box is ticked.
4) Click on "Select Online Files". This will give a pop-up as shown in Figure 19.
5) Only annotated files with the same subject name as that of selected file will be visible in any selected folder.
6) Choose all the annotated and revised files of the subject of interest in one go and click on "Open"
7) The selected files will be named on the "Help Message Window".
8) Now "Online Learning" option will be activated.
9) Check the "Online Learning" check-box
10) Click on Annotate.
11) If the online learning of the same file was previously performed, one can simply click on "Load Predictions" to load them.
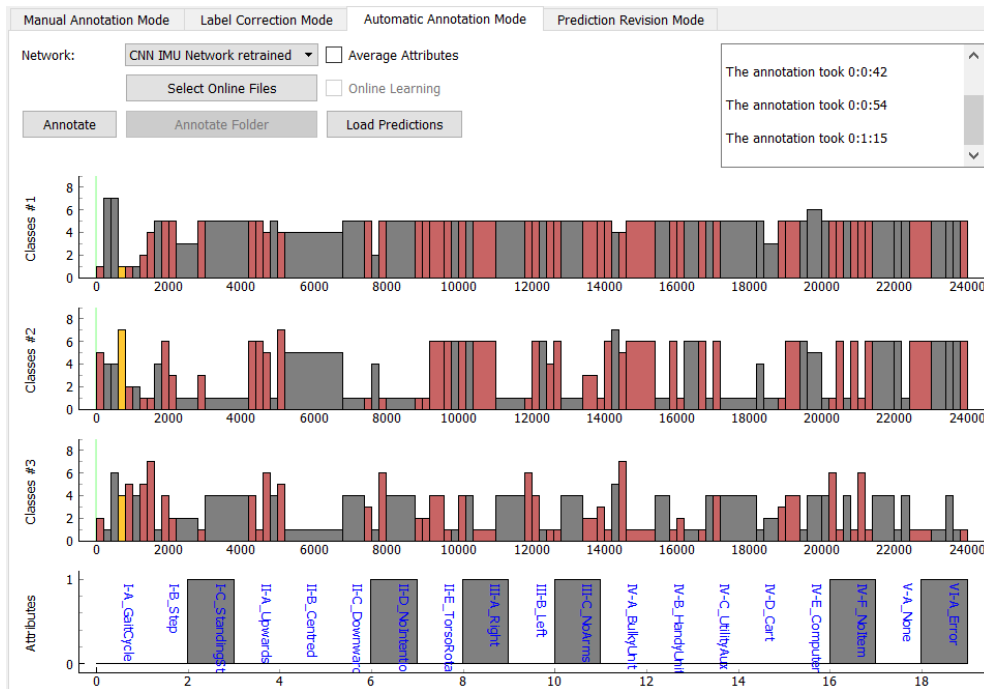

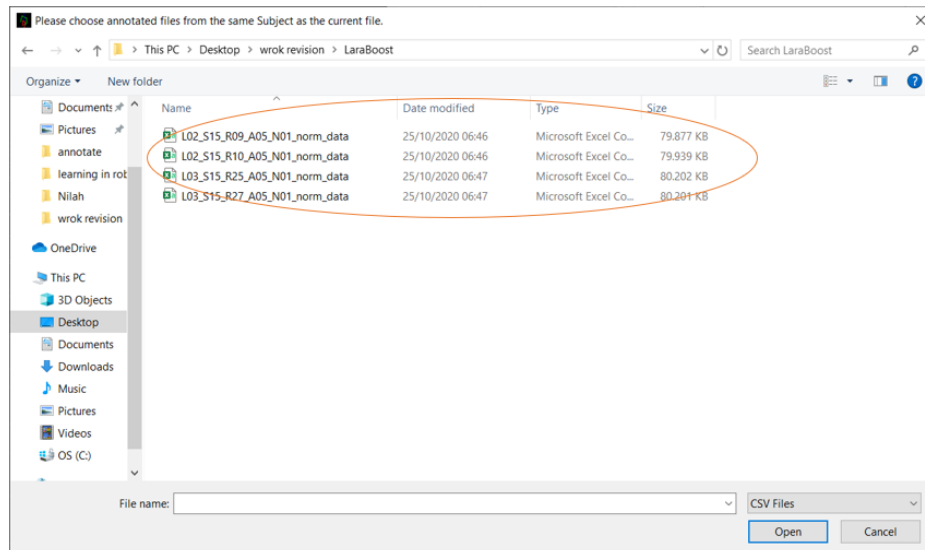*Figure 18: Automatic Annotation Mode*

Figure 19: Online annotation- Files selection

As previously mentioned, clicking on "Annotate" will lead to a dialog box which shows the annotation process progress.

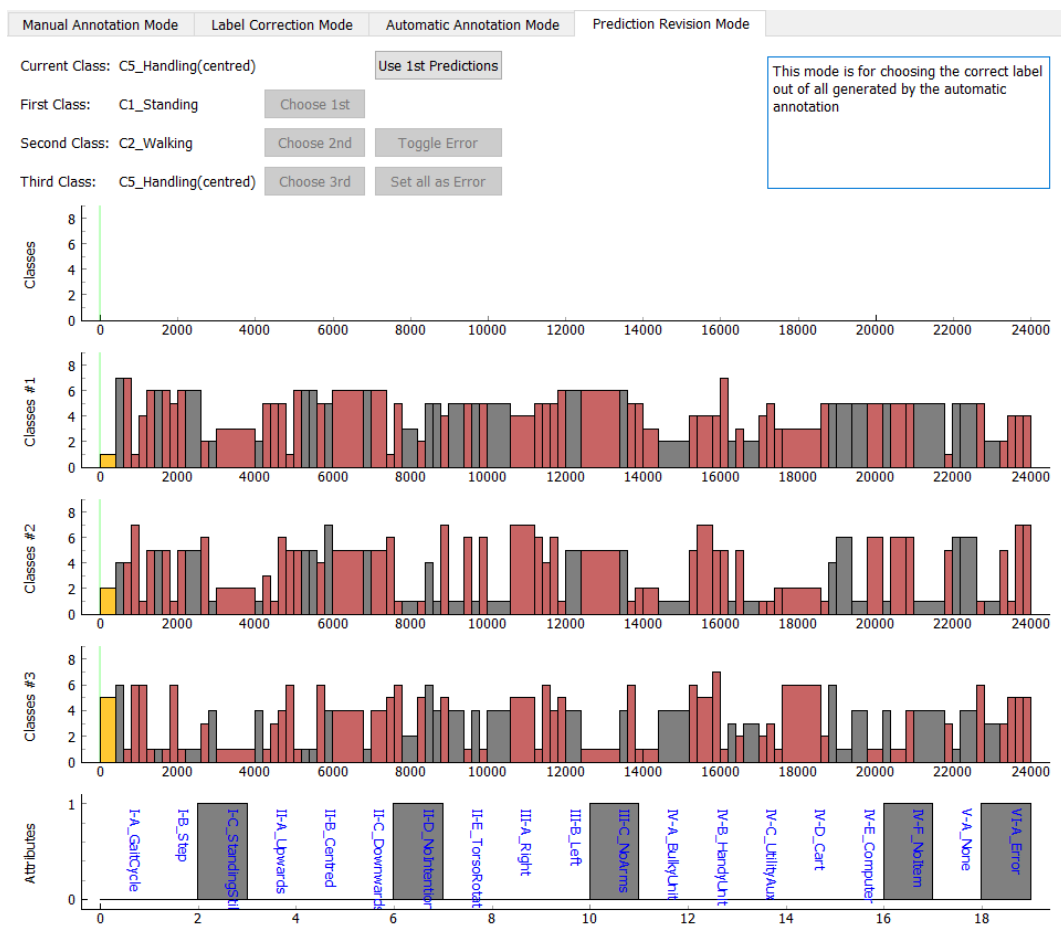## Prediction Revision Mode

Figure 20: Prediction Revision Mode

This mode is used to choose between the top three class predictions of a particular window generated by the neural network. This mode helps you to visualise the quality of the top three class predictions of the neural network in use.

Here, within this mode, the attributes cannot be specifically corrected. To make the correction, one has to toggle to the "Label Correction mode" for the chosen window and correct the attributes. Note that one cannot change the window size while using the Prediction Revision mode. Changing the window size while in this mode is not possible/advisable as this would cause the window-to-class labels to malfunction.

To activate the Prediction Revision Mode, first click on "Use 1st Prediction" button. This will enter the first prediction into the "Classes" graph as shown in Figure 21. Choose the right class from the three prediction while playing the video along. If the required class is not present mark as error by clicking on "Toggle Error" if the window is in grey. To pick an option from the neural network predictions, click on "Choose 1st", "Choose 2nd" or "Choose 3rd". This will make the required change to the Classes graph.

In case the class mentioned is right but there is error (window denoted in red or orange), one could check and correct the attributes from the "Label Correction Mode" and then click on "Toggle Error" to remove the error marking. Or directly remove the error attribute when in "Label Correction Mode".

"Set all as Error" would set all the windows presented in the classes graph as error.

To stop the Revision process, click on "Stop revision mode" this will activate the window splitting tools available in "Label Correction Mode". To make changes to window size, toggle to "Label Correction Mode".

Further to save the work, toggle to "Manual Annotation Mode" tab, click on "verify Labels" and "Save Work".
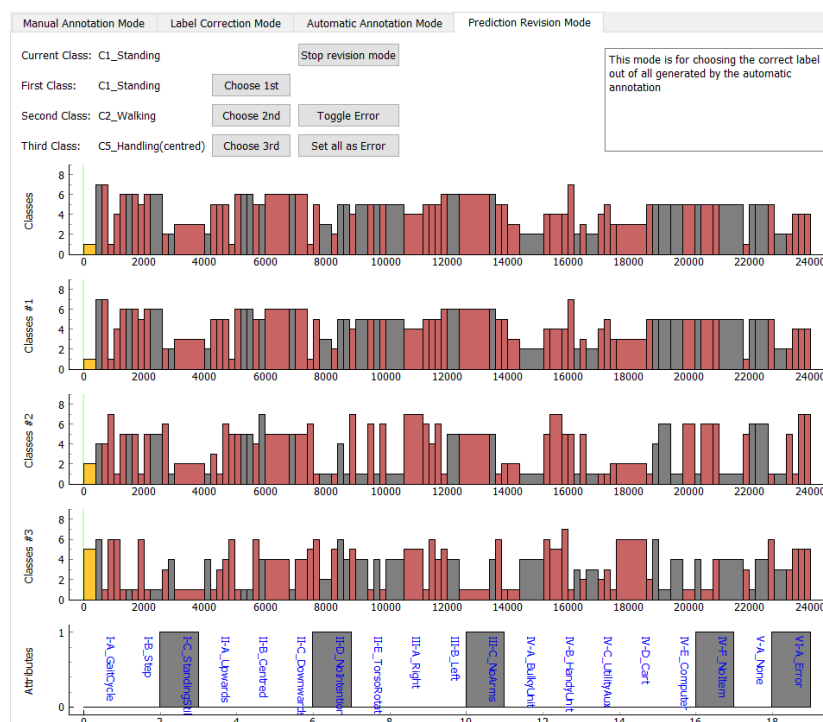

Figure 21: Activated Revision Mode

BEST METHOD OF USE

The best flow of use as per our analysis is to first use the **"Manual Annotation Mode"** to do manual annotation and then perform revision using **"Label Correction mode"** to perform manual revision.

When it comes to semi-automatic annotation mode, we suggest first retrieving the annotation from the **"Automatic Annotation mode"** then in **"Prediction revision mode"** selecting the first prediction set. While in activated **"Predicted revision mode"**, shifting the tab to **"Label correction mode"** and correcting the attributes and classes simultaneously. Mark the windows which may need splitting. Once this round is over, deactivate **"Prediction revision mode"** and do the merging activity in **"Label correction mode"**.

NOTE: Be it in "Manual Annotation Mode" or "Label correction mode" or "Prediction Revision Mode", one needs to verify the labels using the "Verify Labels" present in "Manual Annotation Mode" tab to activate the "Save Work" button.