

Annolid Installation and Quick Start

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1 Installing the Anaconda Environment for Python

If you are not already comfortable in your chosen Python environment, we suggest that you install the Anaconda (or Miniconda) environment for Windows, Linux, or MacOS, with its Conda virtual environment and package manager. These instructions assume a Conda environment. If you already have Conda installed, proceed to section 2.

Installing Anaconda on Windows

1. Download the Anaconda installer

- Go to the Anaconda website: <https://www.anaconda.com/products/distribution>.
- Download the appropriate version of Anaconda for Windows (32-bit or 64-bit).

2. Run the installer

- Once the installer is downloaded, double-click the executable file to launch the installer.

3. Follow the installation wizard

- Follow the prompts in the installation wizard.
- Select the installation location and (optionally) add Anaconda to your PATH environment variable. Follow the defaults unless you have a particular reason to do otherwise.
- Once Anaconda is installed, you can open the Conda environment via the Anaconda Navigator (graphical interface) or the Anaconda Prompt (text window resembling the CMD.exe command line). Both are accessible via the Windows Start menu. We will use the Anaconda Prompt in this document.

4. Verify installation

- Open the Anaconda Prompt from the Start menu.
- In the Anaconda Prompt window, type `conda --version` and press Enter. This command should return the Conda version that is installed. If it works, you have successfully installed Anaconda.

Installing Anaconda on Linux

1. Download the Anaconda installer

- Go to the Anaconda website: <https://www.anaconda.com/products/distribution>.
- Download the appropriate version of Anaconda for Linux. Miniconda also should suffice if you prefer.

2. Run the installer script

- Open a terminal window (Ctrl-Alt-T). We assume `bash` compatibility.
- Use the `cd` command to navigate to the directory in which the Anaconda installer was downloaded. Use the `ls` command to identify the full filename of the downloaded shell script (`.sh` suffix).
- Use the following command to run the Anaconda installer script:

```
bash Anaconda3-<version>-Linux-x86_64.sh
```

Replace `<version>` with the version number of Anaconda you downloaded (that is, exactly match the filename of the downloaded shell script).

- Follow the prompts to agree to the license terms, select the installation location, and confirm the installation.

The Anaconda installer may ask "Do you wish to update your shell profile to automatically initialize conda?". If you say yes, then whenever you open a new terminal you will be in the conda environment rather than in the default bash environment (that is, it will be like opening an Anaconda Prompt under Windows). This is fine, but optional.

Alternatively, you can add the path to the conda executable to your `.bashrc` file manually. Use your favorite text editor to do this; if you don't have a favorite, `gedit` is user-friendly. Type the following into your terminal.

```
gedit ~/.bashrc
```

This will open `.bashrc` in `gedit`, a simple GUI-based text editor. (There should be substantial text in your `.bashrc` file already (>100 lines) – if there isn't, something is wrong; probably you are not editing your existing `.bashrc` but creating a new file, which won't work for present purposes). Append this line to the end of the `.bashrc` file, as shown in Figure 1.

```
export PATH=~/.anaconda3/bin:$PATH
```

Save the file in `gedit` (via its GUI button) and then quit `gedit`.

3. Activate the installation

- After installation, type the following into your terminal).

```
source ~/.bashrc
```

```
118
119 export PATH=~/.anaconda3/bin:$PATH
120
```

Figure 1: The line to add to `.bashrc`, shown in the `gedit` text editor, that will add the conda directory to your system path, enabling conda to be easily run from any terminal.

4. Verify and initialize installation

- Open a new terminal window.
- Type `conda --version` and press Enter. This command should return the Conda version that is installed. If it works, you have successfully installed Anaconda.
- Then, to initialize conda, type

```
conda init
```

- Close the current terminal window.

Installing Anaconda on MacOS

1. Download the Anaconda installer:

- Go to the Anaconda website: <https://www.anaconda.com/products/distribution>.
- Download the appropriate version of Anaconda for MacOS.

2. Run the installer script

- Launch Terminal from the Applications/Utilities folder or by searching in Spotlight.
- Use the `cd` command to navigate to the directory in which the Anaconda installer was downloaded (most likely the Download directory). Use the `ls` command to identify the full filename of the downloaded shell script (`.sh` suffix).
- Use the following command to run the Anaconda installer script:

```
bash Anaconda3-<version>-MacOSX-x86_64.sh
```

Replace `<version>` with the version number of Anaconda you downloaded (that is, exactly match the filename of the downloaded shell script).

- Follow the prompts to agree to the license terms, select the installation location, and confirm the installation.
- After installation, source the `.bash_profile` file to activate the changes:

```
source ~/.bash_profile
```

3. Verify installation

- Open a new terminal window.
- Type `conda --version` and press Enter. This command should return the Conda version that is installed. If it works, you have successfully installed Anaconda.

2 Creating a Conda virtual environment for Annolid

1. Open the Anaconda Prompt (Windows) or a Terminal window (Linux, MacOS).
2. Check the installed version of Conda.

```
conda -V
```

3. Create a new virtual environment for Annolid (here we name this environment *annolid*, but any arbitrary name will suffice) and specify which version of Python to install in that virtual environment. As of this writing, Annolid requires Python 3.11; it is likely to also work with later versions.

```
conda create -n annolid python=3.11
```

4. Activate the newly created environment.

```
conda activate annolid
```

If you have an NVIDIA GPU installed in your computer, and want to use GPU computation (definitely advisable), install and test the packages necessary for GPU computation in Annolid (section 3) before installing the Annolid application. Otherwise, proceed directly to installing the Annolid application for CPU only (section 4).

3 Installing packages for GPU computation

If you have an NVIDIA GPU card installed, you can install Python packages that will enable Annolid to take advantage of these GPU computational resources. The NVIDIA toolkit enabling access to these GPU resources is known as **CUDA**, and the Python packages enabling access to GPU tools via CUDA are collectively known as PyTorch. Installation and configuration of these packages is best done prior to installing Annolid (section 4), but can be done after the fact if need be (discussed at the end of this section). To install these GPU resources, and confirm that they are properly installed and functional, follow the directions below.

1. **Activate the Annolid virtual environment** in Anaconda if it is not already activated.

```
conda activate annolid
```

2. **Verify CUDA Version.** The NVIDIA CUDA toolkit provides a development environment for creating GPU-accelerated applications on NVIDIA graphics cards. To check the current CUDA version installed in your system, open a terminal, Anaconda Prompt, or regular Windows command prompt and run the following command.

```
nvidia-smi
```

The current CUDA version will be listed in the top right corner of the output.

NOTE: If CUDA is not installed, or if you intend to update your CUDA version, do that first. We don't discuss that process here, but the gist is (1) update your NVIDIA drivers, (2) install or update CUDA, then (3) update any other packages, if any, that may be relevant. This is all done at the operating system level, not within Python, Anaconda, or Annolid.

3. **Determine the PyTorch version to install.** Once you have identified your installed CUDA version, you need to select a matching/compatible PyTorch version. Currently available PyTorch versions are listed on the PyTorch.org site: <https://pytorch.org/get-started/locally/>. As of this writing, the most recent PyTorch version was developed for CUDA 12.1, and PyTorch developers have confirmed that this version works up through at least CUDA version 12.4.
4. **Install PyTorch for GPU.** The PyTorch libraries provide access to CUDA GPU resources from Python, and hence from Annolid as well.

From a Conda terminal, with the Annolid environment activated, run the following commands. Note that the argument to `pytorch-cuda` refers to the PyTorch-CUDA version that best supports the version of CUDA that you have installed (rather than the exact CUDA version directly), and the two `-c` arguments are not packages, but specify additional channels in which to search for the listed packages. The other line items – `pytorch`, `torchvision`, and `torchaudio` – are Python packages that will be installed (along with their dependencies).

The following is a standard installation command for CUDA 12.1 (or greater), which will install the most recent compatible versions. (Type this command all on a single line).

```
conda install pytorch torchvision torchaudio pytorch-cuda=12.1  
-c pytorch -c nvidia
```

For example, if you have CUDA 12.2 installed, then specify `pytorch-cuda=12.1`, as 12.2 is not yet specified for PyTorch installation (as of this writing, only versions 11.8 and 12.1 are available). Specifying `pytorch-cuda=12.2` will generate an error message, as no such PyTorch-CUDA version exists.

5. **Confirm PyTorch and CUDA functionality.** To confirm that PyTorch is installed and working with CUDA, first start Python:

```
python
```

You will get the Python >>> prompt. At this prompt, type

```
import torch
torch.cuda.is_available()
```

The latter command should return `True` if CUDA is working. You then can quit Python with

```
exit()
```

6. **If you need to add GPU functionality *after* having installed Annolid for CPU only**, please follow this procedure. Briefly, for a given NVIDIA GPU, you need to install the correct version of PyTorch. When you installed Annolid for CPU only, with `'pip install -e .'` as described in section 4, the installation process installed a CPU version of PyTorch. You now need to change the PyTorch version to match the GPU (and its associated CUDA version), and then inform Annolid of the change by "reinstalling" it (this "reinstallation" process will not update or otherwise alter the present Annolid installation).

First, when in your Annolid Conda environment, install PyTorch for the correct CUDA version as discussed above in this section (line item 4). Then, "reinstall" Annolid using

```
pip install -e .
```

Don't forget to include the trailing space and period in this command.

(If you alter the PyTorch installation for GPU, but do not perform this "reinstallation" step, it may result in a `QBuffer` error, likely associated with the version of the Pillow dependency, which the PyTorch-for-GPU installation may have updated. "Reinstallation" with `pip install -e .` will resolve this `QBuffer` error by ensuring that Pillow is within the version range of `'>=9.3.0,<=9.5.0'`).

4 Installing the Annolid application

1. Activate the Annolid conda environment if it is not already activated.

```
conda activate annolid
```

2. Install `git` and its dependencies (in the Annolid environment), if it is not already installed.

```
conda install git
```

3. Navigate to the directory (folder) on your computer within which you would like to install the Annolid application. (The `git clone` command will create a new directory/folder called `annolid` inside the current directory). The current directory is shown in the prompt of your Anaconda command line. Note that the directory into which you install Annolid (the *application directory*) is not the same as the directory into which Anaconda has installed the packages for your `annolid` Conda environment; in general you will have no need to directly access the latter.
4. Clone the Annolid repository and its submodules using Git. This will install the most recent release of Annolid into a new directory/folder called `annolid`.

```
git clone --recurse-submodules https://github.com/healthonrails/annolid.git
```

You also can specify a different name for your application directory (instead of `annolid`) by appending that name to the end of the above command line. Here we assume that you are using the default name.

5. Navigate to the newly-created Annolid application directory.

```
cd annolid
```

6. Install Annolid in editable mode using pip. (Don't forget to include the trailing space and period in this command).

```
pip install -e .
```

7. From within this same current directory, run Annolid. This will bring up the Annolid GUI, and you can start working with Annolid.

```
annolid
```

The toolbar can be moved between the left side, the top of the screen, and free-floating mode. To do so, grab it by the dotted line at the top/left side and move it with your mouse cursor.

8. Once you are finished working with To deactivate the Annolid environment and return to the base environment, run:

```
conda deactivate
```

To then exit Anaconda, type:

```
exit
```

5 Updating Annolid

There are two strategies to updating Annolid.

1. The first strategy is to use git to update your existing Annolid application to the current version.

- Activate the the Annolid conda environment if it is not already activated, and navigate to your Annolid application directory, which you selected in section 4.

```
conda activate annolid
cd annolid
```

- To fetch the most recent updates from the Annolid repository, use the `git pull` command.

```
git pull
```

- Finally, update your Annolid installation to include these changes. (Don't forget to include the trailing space and period in this command).

```
pip install -e .
```

2. The second option is to remove the Annolid environment (as described in section 6 below) and then install an updated version from scratch as described above.

In either case, you may want to update the conda environment itself as well. We don't discuss that process here in detail, but the basic command is `conda update conda`; additional details are on the Conda cheatsheet (<https://docs.conda.io/projects/conda/en/latest/user-guide/cheatsheet.html>) or in Conda documentation. If the conda version number (as reported by `conda -V` or `conda --version`) does not update as it should, several potential solutions are discussed at <https://stackoverflow.com/questions/73974735/conda-update-conda-does-not-update-conda>.

6 Removing Annolid

If you wish to remove Annolid, the Annolid environment within Conda, and all of its associated packages from your system, first deactivate the environment you are in:

```
conda deactivate
```

You now will be in the conda base environment. Use the following command to remove the Annolid environment:

```
conda env remove --name annolid
```


After removing the Annolid environment, you may then wish to go into the filesystem and manually delete the directory (folder) in which the Annolid conda environment was installed, as the conda remove command does not always remove it completely. To do so, find your Anaconda installation directory (probably entitled `anaconda3`) and navigate to the `anaconda3/envs` directory therein. If there is a subdirectory within `anaconda3/envs` called `annolid` (or whatever the name of your annolid environment was), delete it. Removing this directory is necessary if you intend to create a new Annolid environment in conda with the same name (e.g., to do a clean install of a newer version of Annolid).

To confirm the current list of Conda environments installed on your system, enter:

```
conda env list
```

or

```
conda info --envs
```

Finally, you also will need to delete the Annolid application directory (folder) in which you originally installed the Annolid application by cloning the Annolid repository (section 4).

7 Annolid Help and Discussion Forums

Help is available from the Annolid discussion forums, linked from the Annolid support website, <https://annolid.com> or <https://cplab.science/annolid>. Please use these forums to ask questions, report bugs, or request features. We are always looking for new use cases to support.

8 A Quick Start to Tracking with Annolid

This short guide will get you started using Annolid to track animals or other objects in your videos. It is only a starting point, in which we illustrate the semiautomated segmentation of user-specified objects followed by Cutie-based automatic tracking predictions.

For further details about Annolid’s new (2024) SAM/Grounding DINO-based automatic segmentation coupled with Cutie-based automatic tracking, consult [1]. For some of Annolid’s diverse other behavioral analysis applications, consult [2, 3].

Step 1: Open your video and label instances in one frame

Start by opening Annolid and loading the video you want to work with. You can do this by clicking on the *Open Video* icon in the toolbar or selecting "Open Video" from the File menu.

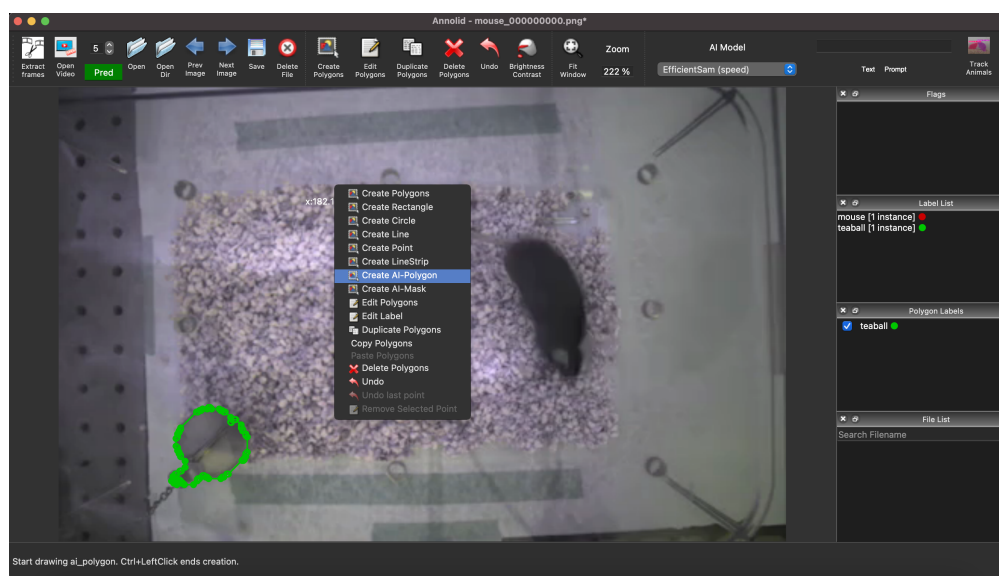


Figure 2: Opening a video and selecting the AI-Polygon tool

Once the video is loaded, navigate to the first frame in which all of your animals and other objects of interest appear. Right-click to bring up the floating menu and choose "AI-Polygon" (Figure 2). (This tool uses Meta’s Segment Anything Model to automatically outline most common objects so that you don’t have to manually draw the outlining polygon, though you can do so if you prefer). Click on the object you want to track, and Annolid will generate a polygon around it. You then can manually adjust the polygon as needed and assign a unique identifier to the instance. Clicking on an object while holding down the Control (Command) key will bring up a pop-up dialog (Figure 3) in which you can enter the information for each instance.

When labeling is complete, use Control-S (Command-S) or click on the toolbar Save button to save the labeled instances to a JSON file.

Step 2: Start automatic predictions (tracking) based on the first frame

After labeling the first frame, it’s time to start tracking! Select "Cutie" from the AI Model pulldown menu and click on the green "Pred" button to initiate the tracking process. Annolid will run its

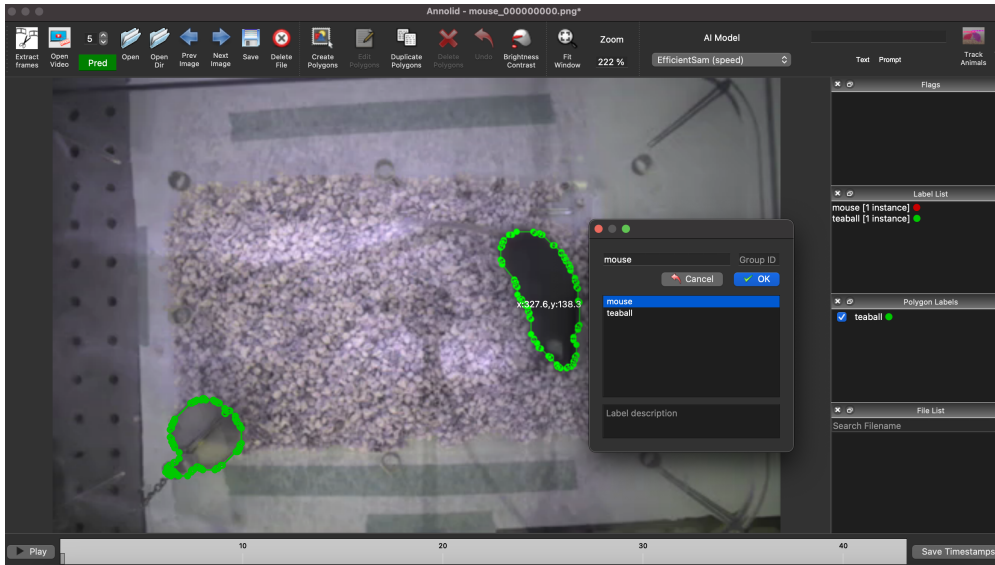


Figure 3: Labeling instances in Annolid (control-click)

model inference in the background, and you can check its predictions in real time by navigating through the completed frames using the slider at the bottom of the screen.

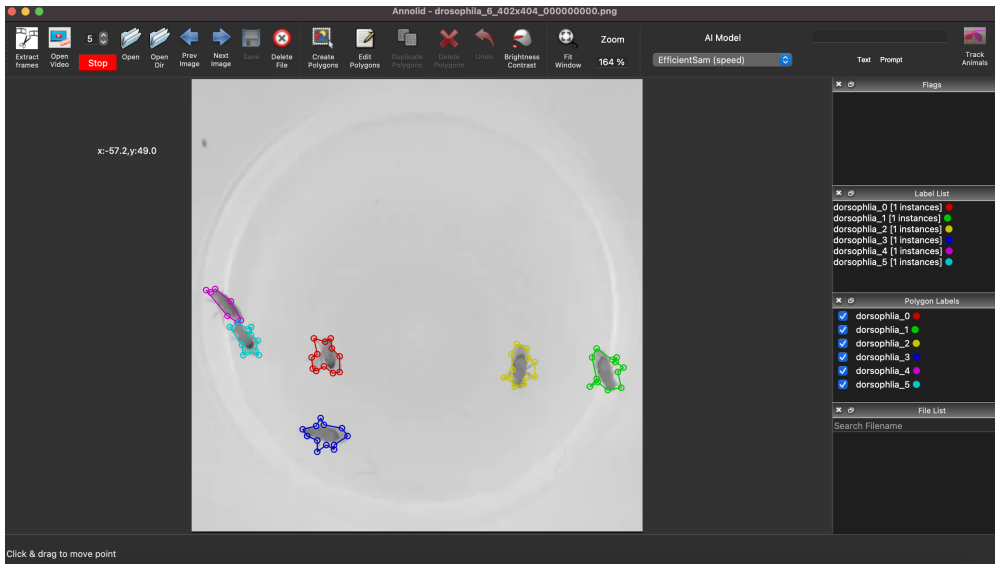


Figure 4: Tracking underway in Annolid

Step 3: Verify Annolid's predictions and correct if necessary

If you notice any inaccuracies in Annolid's predictions, you can stop the prediction process by clicking the red "Stop" button (Figure 4). Once prediction has been paused, navigate to the first incorrectly segmented frame, make corrections as needed (Figure 5), and restart predictions ("Pred" button). Annolid will make new predictions from that point forward.

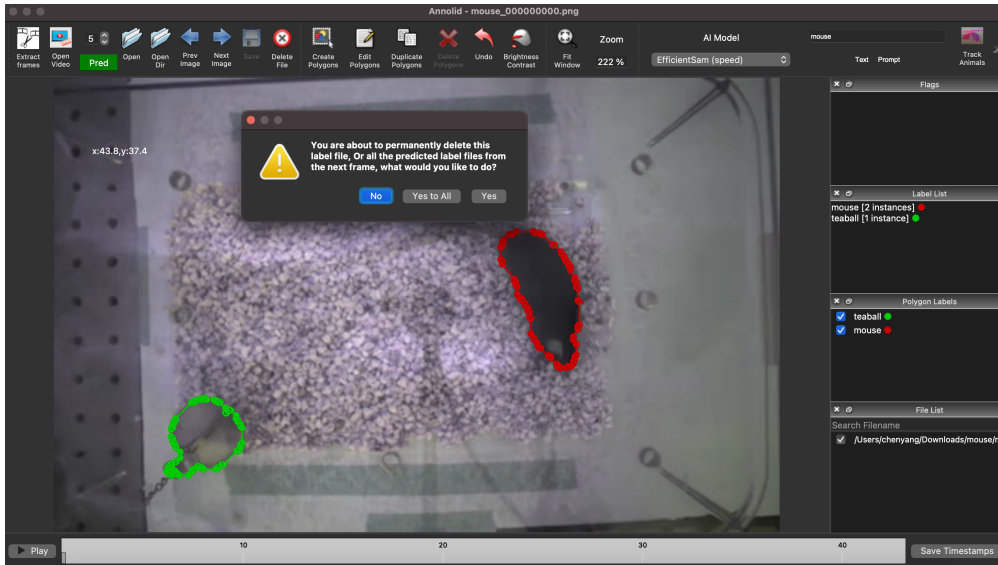


Figure 5: Pausing and correcting predictions in Annolid

Step 4: Finalize the predictions

Once you are satisfied with the tracking, you can finalize the predictions (Figure 6). Annolid makes it easy to review and complete the tracking task, ensuring accuracy and reliability.

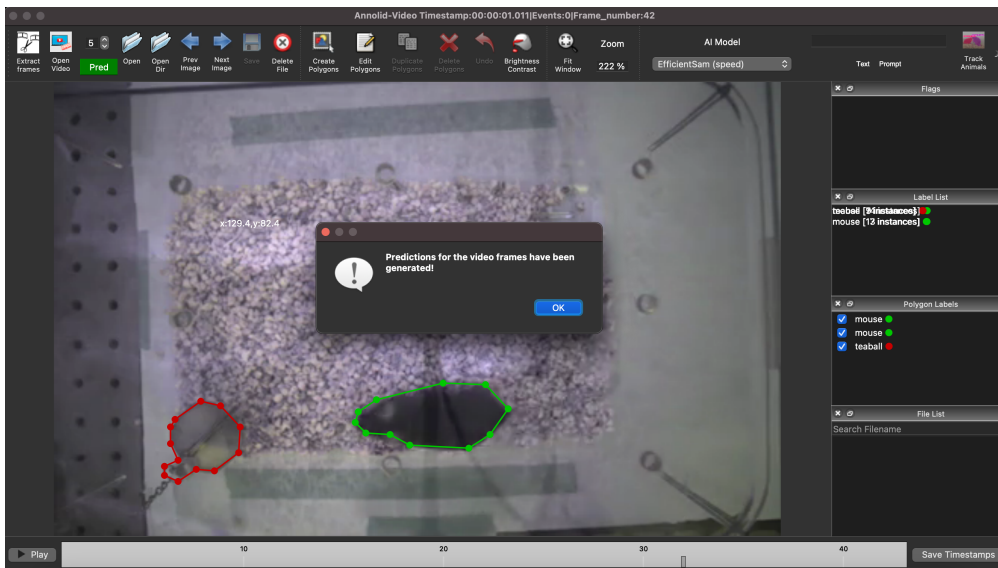


Figure 6: Completing the tracking process in Annolid

Congratulations! You've successfully used Annolid to track objects in your videos. Your tracking results will be saved to a folder with the same name as the video. This folder will contain all the JSON files following the convention 'video_name.frame_number.json', as well as two summary CSV (spreadsheet) files following the filename conventions 'video_name_tracking.csv' and 'video_name_tracked.csv'. More details are available in our published works (see *References* below) and in the online Annolid documentation linked from <https://annolid.com>.

References

- [1] C. Yang and T. A. Cleland, “Annolid: annotate, segment, and track anything you need,” *arXiv:2403.18690*, 2024.
- [2] C. Yang, J. Forest, M. Einhorn, and T. A. Cleland, “Automated behavioral analysis using instance segmentation,” *arXiv:2312.07723*, 2023.
- [3] J. Fang, C. Yang, and T. A. Cleland, “Scoring rodent digging behavior with Annolid,” *Soc. Neurosci. Abstr.* 512.01, 2023.