Onepanel

AI Pipeline Operations Manual

University of Guam - CRB Damage Pipeline v.1.0

Document v1.0

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Setting up CVAT on Onepanel

CVAT is available by default on Onepanel CE and can be used off-the-shelf. However, you might want to change some configuration settings based on your usage. For your convenience, we have set up a separate environment for this project, which can be accessed at https://app.uog.onepanel.io/crb/workspaces.

Data Collection

The videos uploaded on S3 so far look good and can be used for training models. However, there are some points that we would like to point out certain things that might affect the model's accuracy. It is recommended that the videos are recorded at 20 fps or higher.

- Image Quality: It is highly recommended that we have high resolution frames where we can clearly see all the objects. Current frames have 1920 x 1080 resolution which is quite good. Please note that higher resolution also affects model training and inference time.
- Orientation: As it can be seen in the videos, most of the time trees are on either the left or right side of the frame. It might be helpful to record some videos where the camera is slightly aligned toward left or right.
- Class Balance: If our dataset has high class imbalance then it will be hard to achieve good accuracy. It always recommended that the data we capture has all types of objects that we are interested in.

Creating CVAT workspace

Click on the Workspaces tab to create a new task. There you will find a button named CREATE WORKSPACE. There you can select the CVAT template and specify sizes for the various drives as shown below and hit on Create and Run.

Additionally, you can change the template by clicking onto Template Builder. There you will find a template for CVAT and other templates and also an editor to edit these templates.

Onepanel

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Create Workspace

Template
CVAT ▾

Workspace name
name

Must be between 3-30 characters, contain only alphanumeric or '-' characters

Node pool
CPU: 4, RAM: 16GB ▾

Name of node pool or group

Disk size for "db"
20480

Disk size in MB for volume mounted at `/var/lib/psql`

Disk size for "data"
20480

Disk size in MB for volume mounted at `/home/django/data`

Disk size for "keys"
20480

Disk size in MB for volume mounted at `/home/django/keys`

Disk size for "logs"
20480

Disk size in MB for volume mounted at `/home/django/logs`

Disk size for "models"
20480

Disk size in MB for volume mounted at `/home/django/models`

Disk size for "share"
20480

Disk size in MB for volume mounted at `/home/django/share`

Labels

⊕ ADD LABEL

Creating new tasks

Once you're inside the CVAT dashboard, you can create new tasks to start annotating. You will find a Create New Task button on top, clicking on it will open up a new pop up window as follows:

Now, you give this task a name you like. Then, labels that you are interested in annotating (i.e car, bicycle). You also need to select the source of your data (images). You can upload from your local machine or use data uploaded to S3. If a particular video has more than 4000 frames, we recommend creating multiple tasks with each task containing a certain number of frames (i.e 4000). This can be achieved by setting start and stop frame in Advanced settings as shown below.

Using data from S3

We have already set up the following things for you, so you don't have to do anything in order to use data from S3.

If you want to use data from your S3 drive while creating a new task. You must set `SYNC_S3_BUCKET_NAME` environment as mentioned above. Now, you can select `Connected file share` while creating a new task. It will show all the files from S3 bucket, or from the directory if you set `SYNC_S3_PREFIX`.
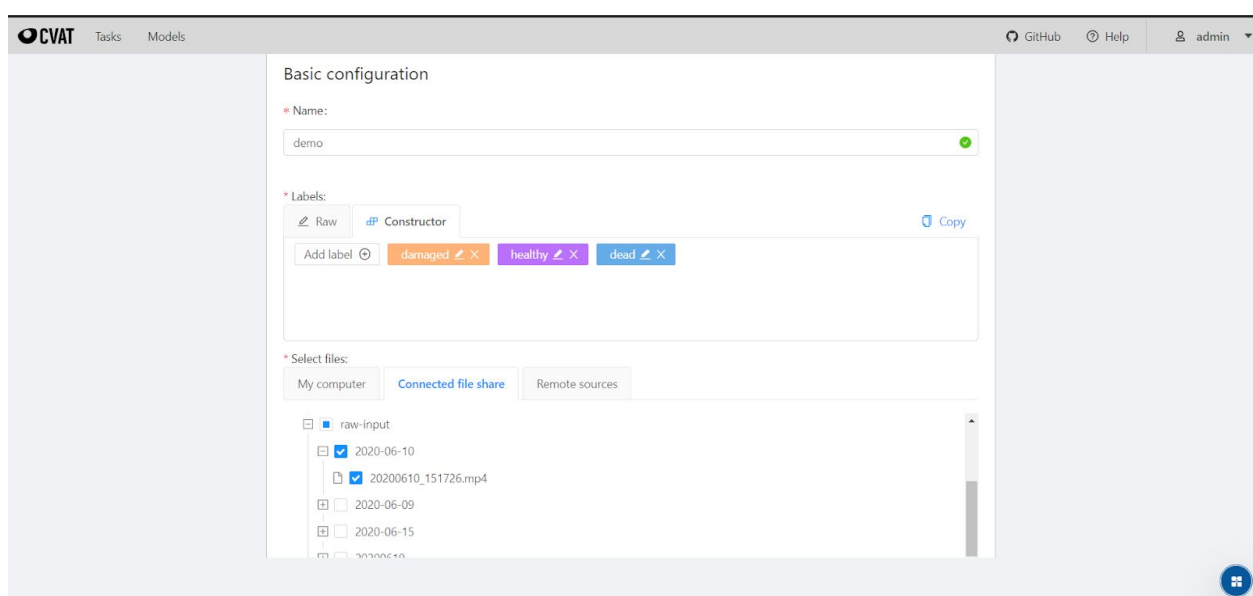
Above image shows how you can access data from S3 while creating a new task. Please make sure that you upload videos (data) inside the **"raw_input"** folder on the S3 bucket. We can also set up tasks for you to ensure everything goes smoothly.

Manual annotation

Once you have created a new task, you can start annotating your data. CVAT supports points, box, polylines, polygons for annotation. So, the first thing you should do is go to the left sidebar and select the type of annotation you want as shown below.
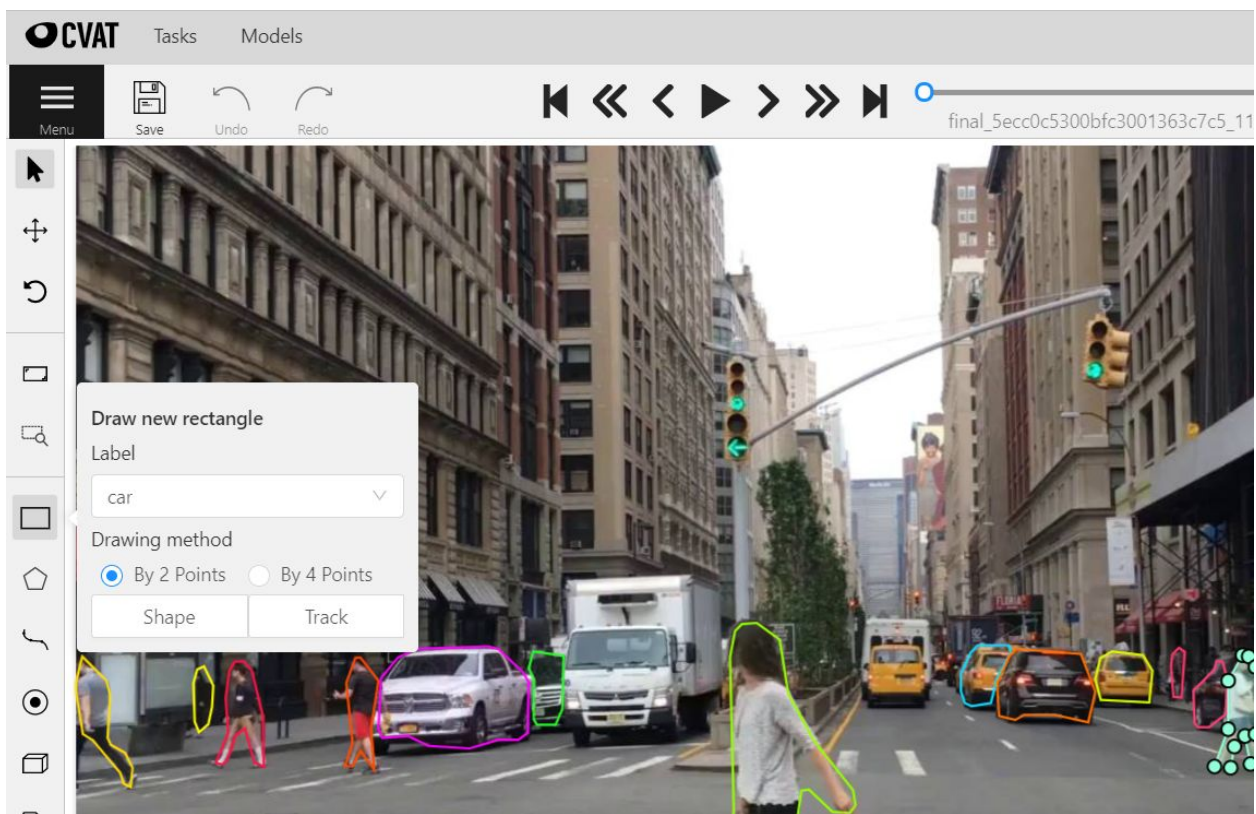
Bounding box

You can annotate bounding boxes by clicking on the rectangle box on the left side bar. After clicking on the rectangle button on the left sidebar, please select the Shape button as shown above. Then, you can start annotating boxes. You can use the N key to draw the box as well. But there are two types of boxes as you can see above. Shape and Track. We want Shape for this task. Sometimes pressing N draws a Track box. To make sure shortcut N draws Shape we just need to draw one Shape manually by clicking on the rectangle button as I described above.
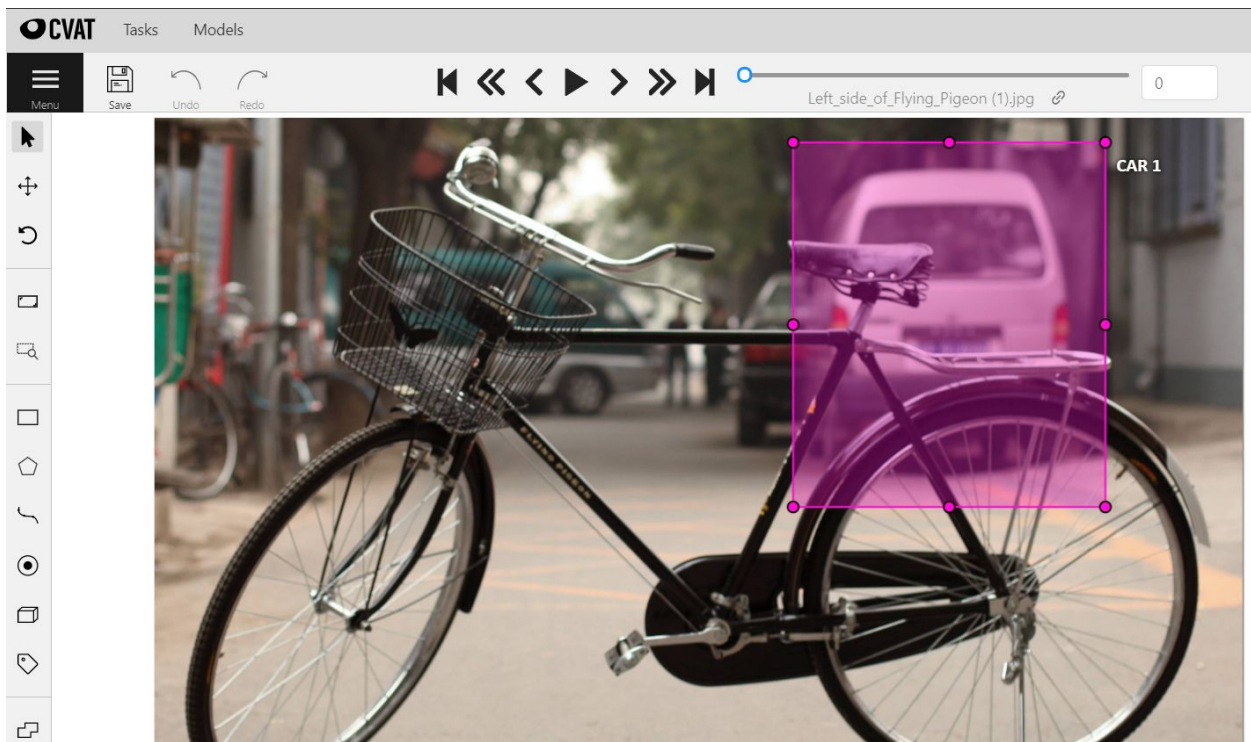
If you want to change the class of an object. Finish drawing the bounding box around an object, then go to the right sidebar and change the class from a dropdown menu. The same has been highlighted in blue color in the above picture.

Points

If you want to annotate points, then select Points instead of Box which is a default choice. Once you select points, you can start annotating by clicking on Create Shape, clicking on the image where you want to put the point, and then click on stop shape. Or alternatively, you can use keyboard shortcut N instead of Create Shape/Stop Shape. Make sure you periodically save your annotation by pressing ctrl + s.

Polygons

Similarly, select polygons or polylines and follow the same procedure for annotation. You can find the polygon or polyline on the left sidebar.

You can see the list of annotations per frame on the right-hand side.
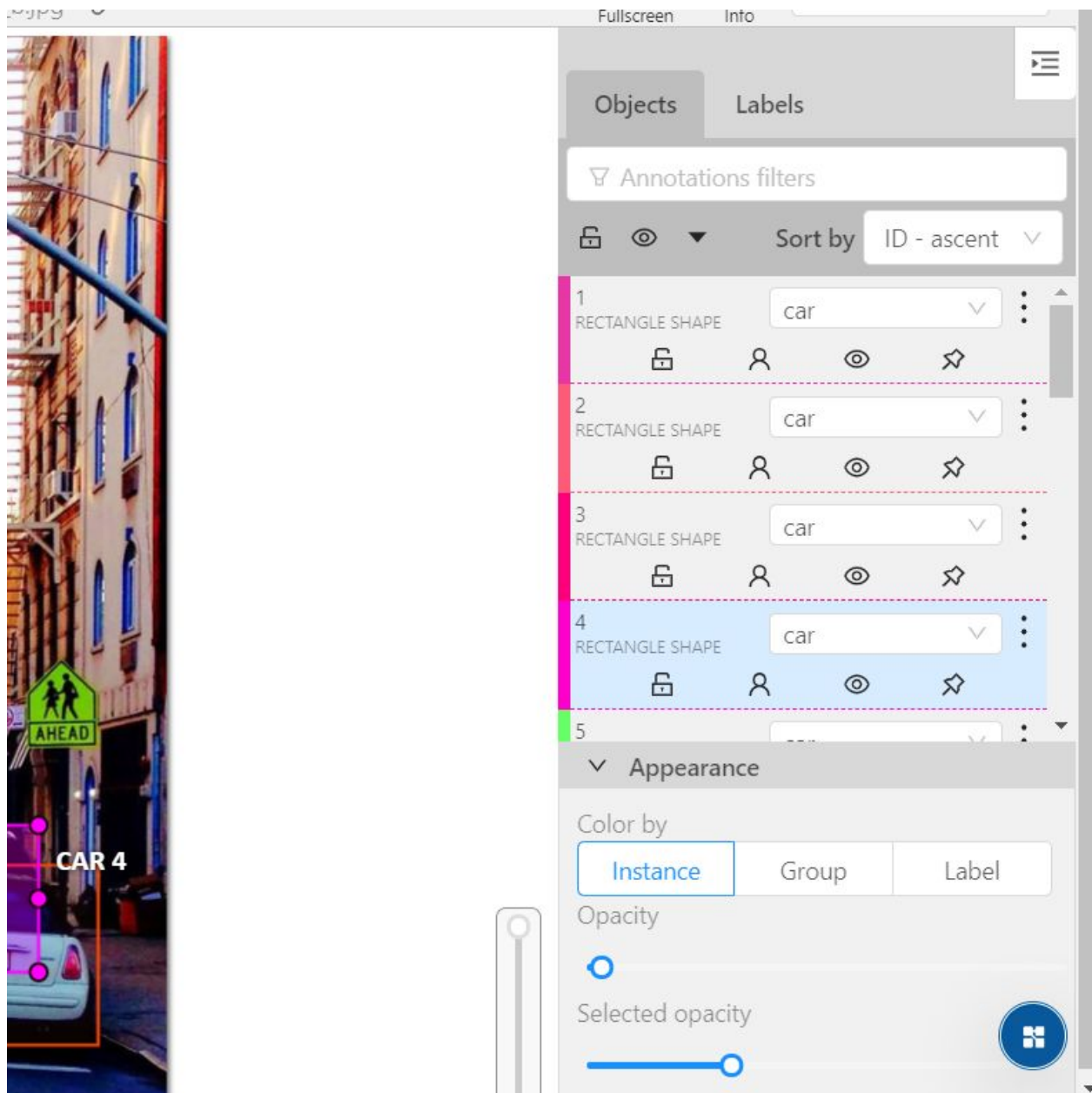
Annotation requirements

The accuracy of machine learning models depends on the quality and size of the dataset. This section describes how to annotate the frames for this task.

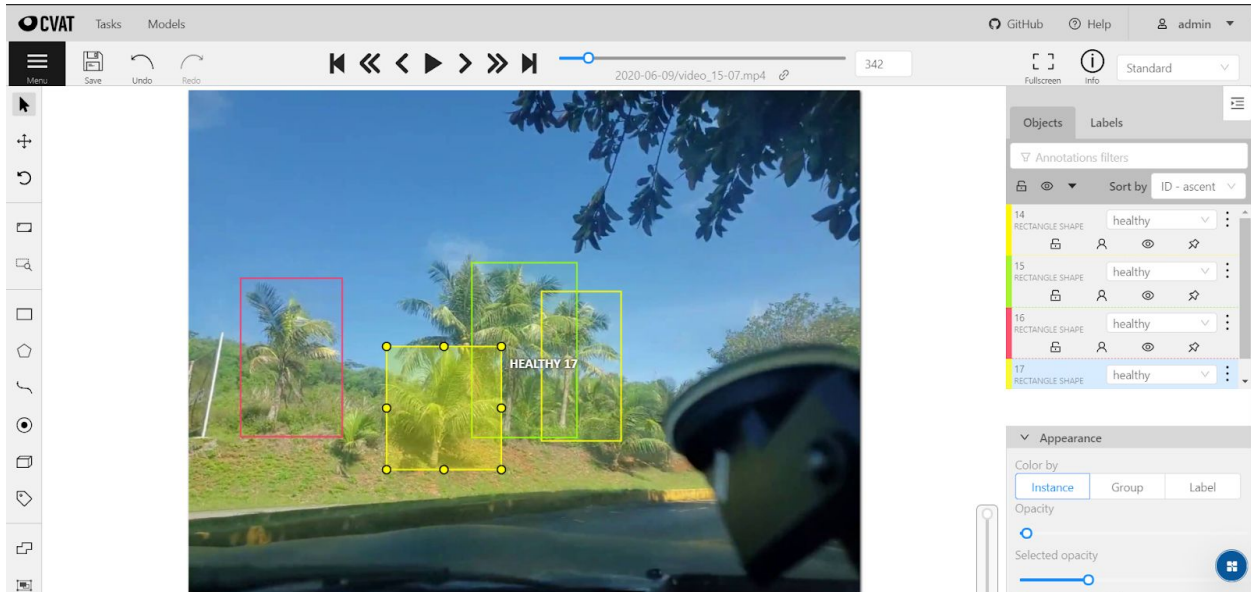Ideally, we should annotate all the objects in the current frame if it's one of the objects that we are interested in. However, it is also important to know when not to annotate a particular object. For example, in the above frame, we did not annotate a tree left to the green bounding box as it was hard to be noticed even by the human eyes. In simple terms, we should annotate all the objects that can be perceived and classified by the human eyes.

As mentioned before, please make sure that you annotate Rectangle Shape (vs Rectangle Track) as it can be seen on the right sidebar of the above image. Pressing the N will draw Rectangle Track sometimes. But if you do one Rectangle Shape manually by clicking on the rectangle box on the left sidebar then N will draw Rectangle Shape subsequently.

If you realize you labeled any object incorrectly, you can change the label from the right sidebar as shown below.
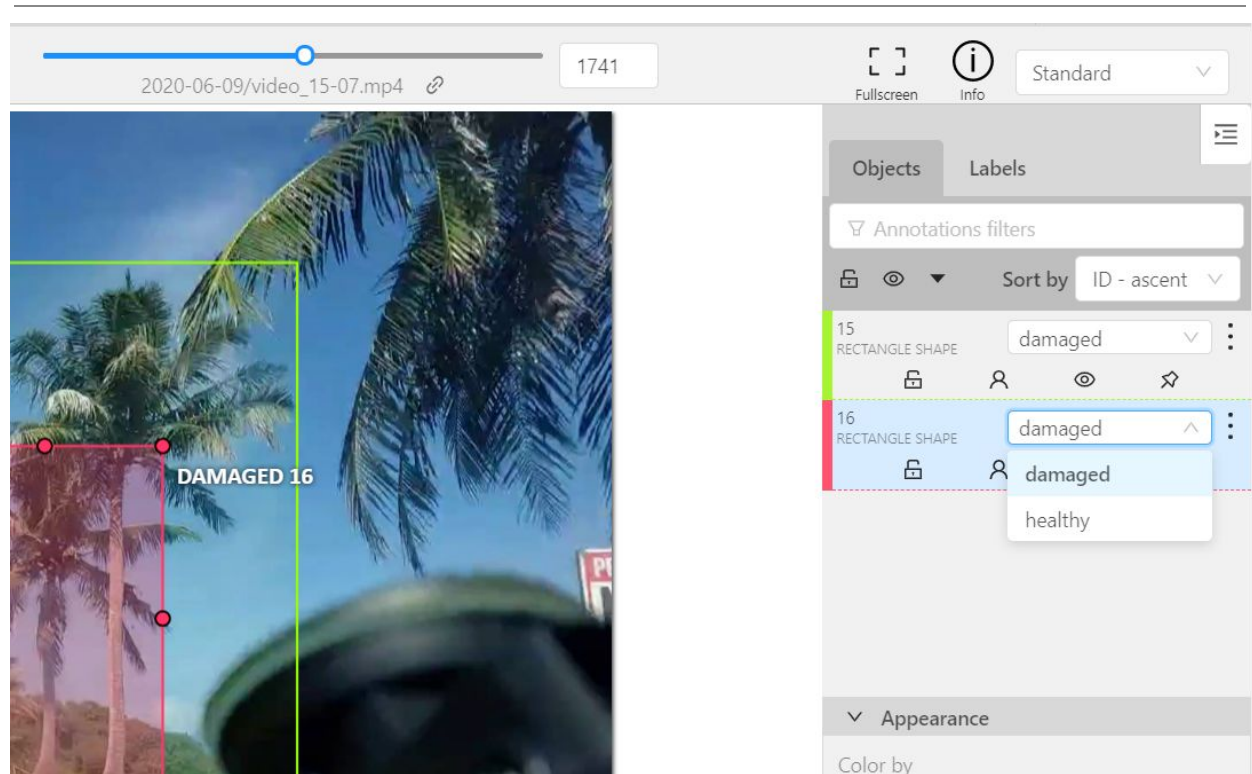
Using pre-annotation models

Onepanel's CVAT supports a feature to pre-annotate images for common objects. In order to use any pre-annotation feature, you first need to upload the model. By default, we provide a default model for bounding box annotation. Click on Models, and give a name to it. Click on select files and upload your model (.pb and .csv file). Hit submit to upload the model.

You can also use files from "Connected file share" if you set appropriate environment variables.

Once you have the models in Model Manager. Click on Automatic Annotation under Actions menu. Then, you will be asked to select the model you want to use for pre-annotation. You can also control the class mapping from your task's classes to the model's classes. Once done, click on Submit to start pre-annotation. Once it's done, you can click on the task link to access the annotation.

Upload a new model

* Name:

frcnn-custom ✓   ☐ Load globally

* Select files:

My computer   Connected file share

📥

Click or drag files to this area

Support for a bulk images or a single video

🔗 frozen_inference_graph (1).pb

🔗 classes (3).csv

Submit

Training new annotation model

Onepanel also allows you to further finetune your model for annotation. Once you are done with your annotation or adjustment to pre-annotation, you can train a new model on it. To do so, go to the dashboard and click on Actions under the task for which you want to train a model.

There, you can select the Tensorflow OD API for bounding boxes or Mask RCNN for segmentation.

For TensorFlow OD API, we support multiple models. In fact, its dynamic. You can also train the model you like as long as it is supported by Tensorflow Object Detection API. The training will be performed in the form of workflow execution. The trained model will be stored on S3. The path to the exact directory is determined by some environment variables. Let's say your namespace name is crb, task name in CVAT is test, then your trained model for TensorFlow object detection will be stored at "s3 bucket -> datasets (env var) -> crb (namespace name) -> test (task name) -> models ->

test_tfod_ssd-mobilenet-v2-coco_<timestamp>/". The last folder name starts with task name, and contains words describing which type of model is there.

Arguments (optional)

You can optionally specify some arguments in the Arguments field separated by ;.
Here is a sample: epochs=100;batch_size=24;.

- epochs : number of epochs to train your model for. By default, we will train for an appropriate number of epochs depending upon the model.
- batch_size : batch size for the training
- initial_learning_rate : initial learning rate for the model. We recommend you do not change this.
- num_clones (default=1): number of GPUs to train the model

If you select a Machine type with 4 GPUs (Tesla V100), the following command can be used: epochs=300000;num_clones=4

- Note that num_clones is 4 because there are 4 GPUs available.

Choosing the right base model

You can use any of the models that we support to train your custom pre-annotation models. Here, we provide a brief explanation on how to choose one model over another based on your needs. Some models are faster than others, whereas some are more accurate than others. We hope this information will help you choose the right model for your task.

- We currently support a few faster-rcnn models. All of these models are similar except that of the backbone used for the feature extraction. The backbones used are, in increasing order of complexity (i.e more layers), ResNet50, ResNet101, InceptionResNetV2. As the model complexity increases the computation requirement will also increase. If you have very complicated data (i.e hundreds of annotations in one image), then it is recommended that you choose a complex model (i.e InceptionResNetV2).
- Faster-rcnn models are generally more accurate than ssd models. However, sometimes you are better off using ssd models if your data is easy to learn (i.e 1 or 2 bounding box per image).
- **For this task**, we recommend experimenting with faster-rcnn-res101, faster-rcnn-res50, and ssd-mobilenet-v2.

How to run inference on test data using trained model

First you need to download your model from S3 or use Connected file share. For Object Detection, you need **frozen_inference_graph.pb** and **classes.csv** files which can be found in the trained directory on S3.

Often you are required to make predictions on test data. Using CVAT on Onepanel, you can easily train/test your model and visualize output. Once you have the trained model, upload it to the CVAT by clicking on `Create new model` on `models` tab.
Now, create a task with your test data.

Click on Actions for that task and select Automatic annotation. Select the model you just uploaded and hit submit. It will run the inference using the model you selected. Below is a sample frame whose output was generated using the trained model.
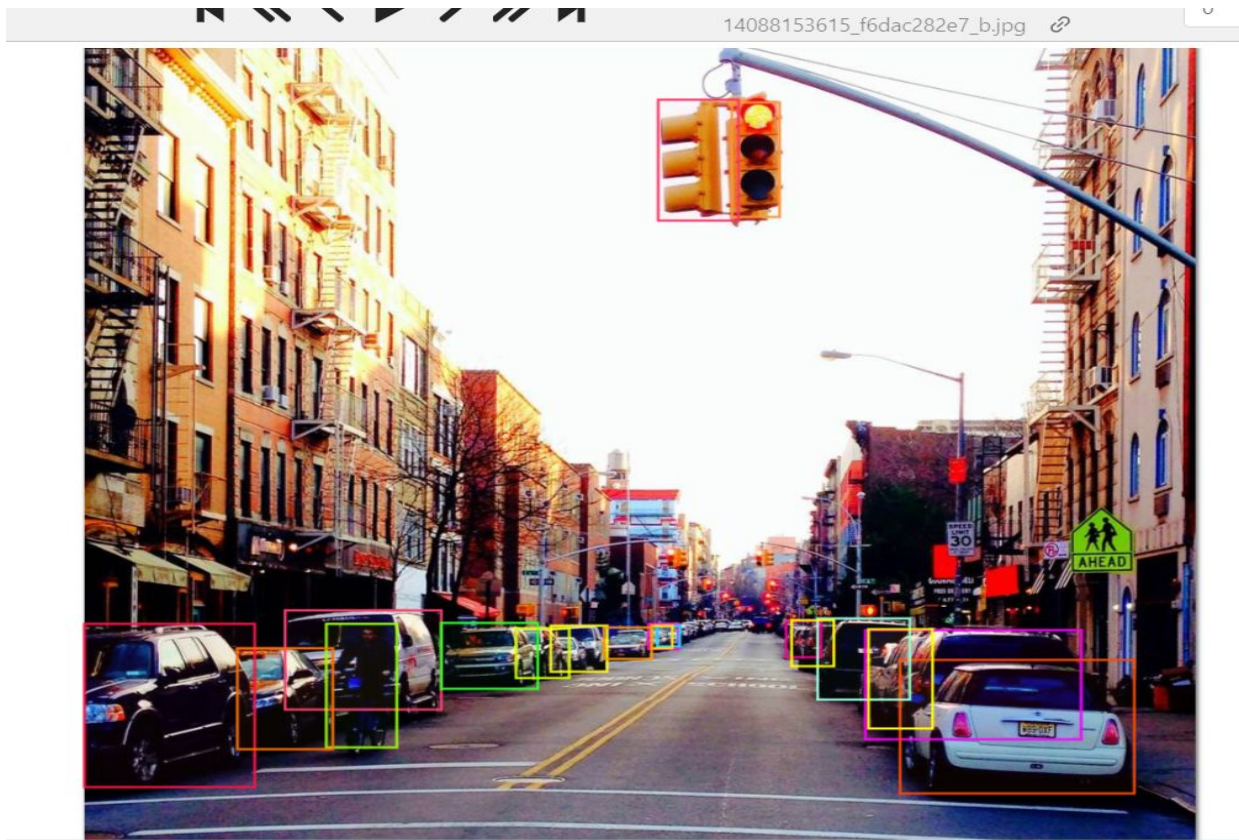
Compute and space requirements

For training a model (Create New Annotation Model), you can choose any available GPU or CPU machine from the list. But if you want to train it faster, then we suggest you select machines with multiple GPUs (i.e 8 V100).

For pre-annotation, you can use a CPU machine (32gb or above) for TF Annotation (bounding box). But It will be considerably slower. So, we suggest you choose a GPU machine for pre-annotation.

For the pre-annotation of polygons, you have to use a GPU machine since the Mask RCNN model is compute-intensive.

Please find the table below which details machine type with the corresponding runtime to perform pre-annotations. For this test, we used a task with 3550 images (2GB) to perform pre-annotations.

Machine	Time
K80	160 minutes
V100	80 minutes
V100 x 4	21 minutes

Run time depends on factors such as model, number of images, type of machine. The above data was generated for ssd-mobilenet-v2 model which is the model we suggest to use in normal circumstances. If you have complex annotations and want to use a faster-rcnn based model, then it might take slightly more time. But note that it won't significantly alter the data presented above.

The other factor is image compression. By default, CVAT compresses images by 70%. We did some testing to find out if we use original images (without compression) then how much time it will take.

It turns out that if you use the original images without compression, your pre-annotation time will be increased by ~5-6% of that of 50% compressed images. So in the above table, if you use images without compression and use a V100, it will take 84 minutes instead of 80 minutes. Please note that this compression does not affect annotation in any way.

Note that this data was calculated on 3550 images (1280 x 960)(total size=2GB), so if your data size is different you can easily extrapolate the data from the above table. For example, if you have 10gb of images then ideally it will take around 400 minutes on a V100 GPU.

If the resolution of your images is slightly different, then it won't affect run time significantly. In fact, if the difference is ~200 pixels then it won't change at all, generally.

To conclude, most of the tasks can be performed on a 32gb machine. But we recommend GPU machines for certain tasks such as training a model to speed up the process.

There are multiple storage drives for CVAT on Onepanel. The important ones are data, db, models, and share. The default values for each drive is 20GB. But depending on your usage we recommend following changes.

- If you are going to create tasks with large videos or many frames, it is recommended that you increase the size of the data drive while creating the CVAT workspace.
- If you will be dealing with training and testing models a lot, then you can increase the size of the models drive.
- The db drive stores the databases and would reflect the case of data drive.
- The share drive is an important one if you will be using shared storage. The syncer will download all files from S3 (or directory, if you specified) to this drive. If your bucket/directory has so many files or you anticipate to upload many files, then please update the size of this drive accordingly.

References

- Onepanel quick start guide (https://docs.onepanel.ai/docs/getting-started/quickstart).
- Information about Onepanel Workspaces (https://docs.onepanel.ai/docs/getting-started/concepts/workspaces).
- CVAT documentation on Onepanel (https://docs.onepanel.ai/docs/getting-started/use-cases/computervision/annotation/cvat/cvat_quick_guide).