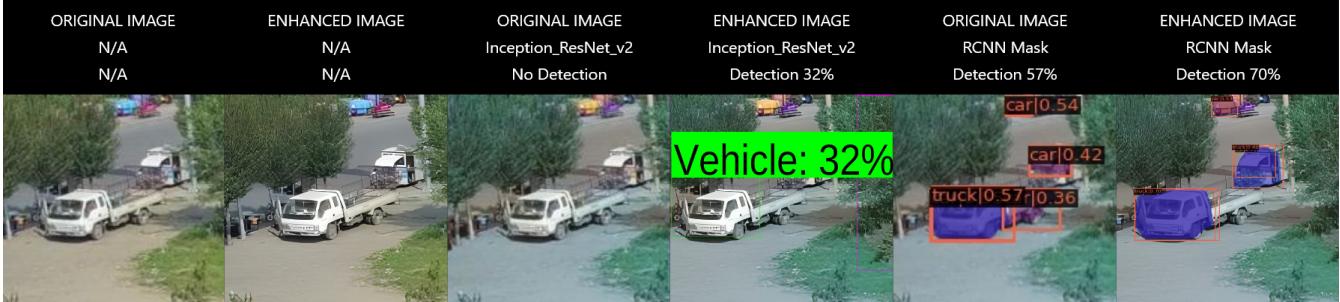


Improving Object Detection in Surveillance Footage using ESRGAN Image Upscaling and Inception ResNet v2

Yulian Kraynyak¹, Yegor Chernyshev²

New York University, Tandon School of Engineering



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Abstract

Despite advances in camera systems and video recording technologies, many surveillance systems suffer from low-quality footage, storage compression and general loss in fidelity. We theorize that through the application of machine learning for image quality improvement, detection of objects and persons of interest in surveillance data could be substantially improved. We collected various publicly available datasets, including VisDrone as well as publicly available surveillance videos, utilizing Real-ESRGAN for image enhancement and Inception ResNet v2 for object detection. We believe this conceptual framework has the potential to benefit and improve upon home security, search and rescue teams and law enforcement, among others.

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¹ yk2562@nyu.edu (Yulian K.)

² yc5109@nyu.edu (Yegor C.)

1. Quad Chart

Purpose	Results
Despite advances in camera systems and video streaming technologies, many surveillance systems suffer from low-quality devices, storage compression and loss in fidelity. Our goal is to increase the detection confidence of persons and objects of interest in low quality surveillance footage. Many fields would benefit from this work, including home security, search and rescue teams, law enforcement and military among others.	We found that although the enhanced footage had more visual clarity (and hence improved object detection by eye), the total average of the top 10 confidence scores of the enhanced footage wasn't always consistently higher than the raw, untouched footage. Our approach tends to improve object confidence scores on color footage, but tends to result in lower total averages on grayscale footage.
Procedure	Analysis
<ol style="list-style-type: none"> 1. Perform object detection on original surveillance footage. 2. Perform object detection on footage enhanced using Real-ESRGAN footage, using Inception ResNet v2. 3. Compare results of both, measuring the average confidence score of the top 10 detected objects in the footage. 4. Test the same procedure on various datasets, including user uploaded video data, publicly available surveillance footage, and VisDrone datasets. 	Object detection in enhanced footage improved, however minimally. Results were heavily dependent on the quality and duration of the original surveillance footage, as well as the color profile of the footage itself. Full color, longer videos performed much better, resulting in consistently higher average object confidence scores after being passed through Inception ResNet v2, while grayscale, shorter videos resulted in average scores either matching or underperforming the average scores of the enhanced videos.

2. Procedure

2.1. Image Enhancement & Upscaling

We initially attempted to upscale images using GFPGAN³ which provided impressive results, but did not provide the dramatic changes we were looking for. We instead turned to the state-of-the-art model for image supersampling, Real-ESRGAN⁴. We went one step further and tried another state-of-the-art model, SWIN IR, however, we found the, near un-noticeable, differences in image quality improvement to be negligible. It is possible that SWIN IR⁵ may have provided slightly better end results on our object detection model, but to achieve that would have required extensive training time on the model, so we decided to stick with Real-ESRGAN. We initially ran our dataset through a pretrained model provided by the researchers. However, we believed that further visual improvements could be achieved by applying transfer learning to the model, and retraining it on our dataset. Our original dataset included 6,000+ images, and the default training parameters of the model were set to run through one million iterations. When attempting to train using this setup, we came to realize the estimated time for completion would have exceeded 11 days. So we decided to use a randomly selected subsample of our data consisting of only 500 images and decreasing the model's training iteration count to 10,000. The training run was done in batches of 12 images, running 42 iterations per epoch. The total number of epochs was 239. The optimization function used was

³ Wang, Xintao, et al. "Towards Real-World Blind Face Restoration with Generative Facial Prior." 2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2021,

<https://doi.org/10.1109/cvpr46437.2021.00905.>,
<https://github.com/TencentARC/GFPGAN>

⁴ <https://github.com/xinntao/Real-ESRGAN>

⁵ Liang, Jingyun, et al. "Swinir: Image Restoration Using Swin Transformer." 2021 IEEE/CVF International Conference on Computer Vision Workshops (ICCVW), 2021,

<https://doi.org/10.1109/iccvw54120.2021.00210.>

Adam with a learning rate of 0.0002. The neural network comprised 23 blocks, having 3 input channels, 3 output channels and 64 features. Each of the 23 blocks were made of 3 RedidualDenseBlocks, each with five 2D convolutional networks and one ReLU activation. For each convolutional layer, the kernel size was set to (3,3) with a stride of (1,1) and a padding of (1,1). Although we noticed slight improvements in visual outcome on our small dataset, the accuracy of object detection did not perform any better than the original model, which we will discuss next.



Original Frame



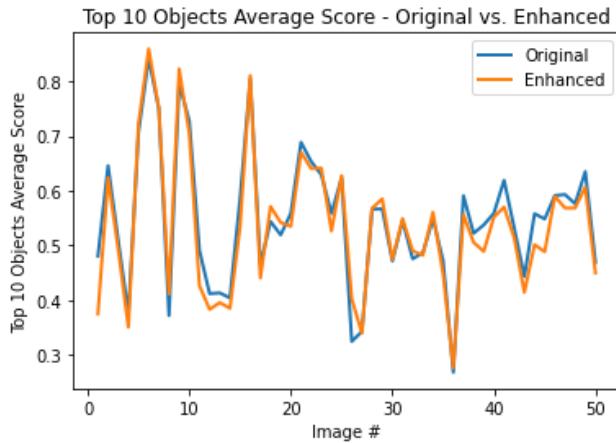
Enhanced Frame

2.2. Object Detection

We performed object detection at various stages in our process. Initially, we ran object detection on our original, unmodified dataset, to serve as a baseline to compare against after

upscale the images. We decided to go with Google's Inception_ResNet_v2⁶ due to its open nature allowing us to easily tweak, train and modify the model to fit our needs. Due to the large amount of objects in our images, we decided to focus only on the objects which had the top ten highest detection confidence scores. Overall, the model performed well, but the exact score varied substantially on the image it was applied to, ranging from 30% detection accuracy to 80% (see graph below). Next, we ran the model on the Real-ESRGAN enhanced footage.

Object Detection Results Using Our Fitted Real-ESRGAN Model For Image Enhancement



Original Frame

Average object score = 0.70772093989028931



Enhanced Frame (Real-ESRGAN)

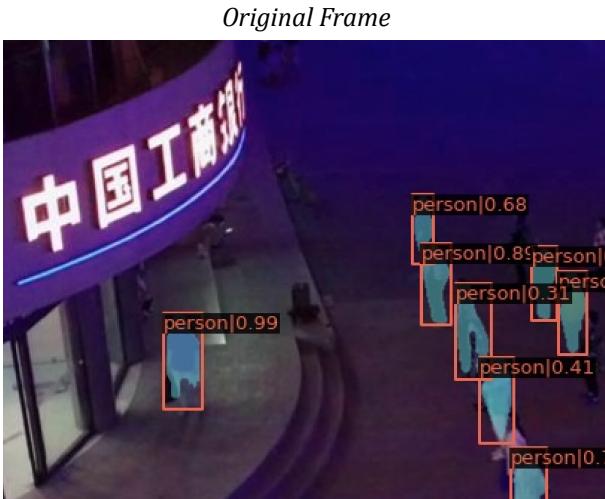
Average object score = 0.724141538143158 ↑



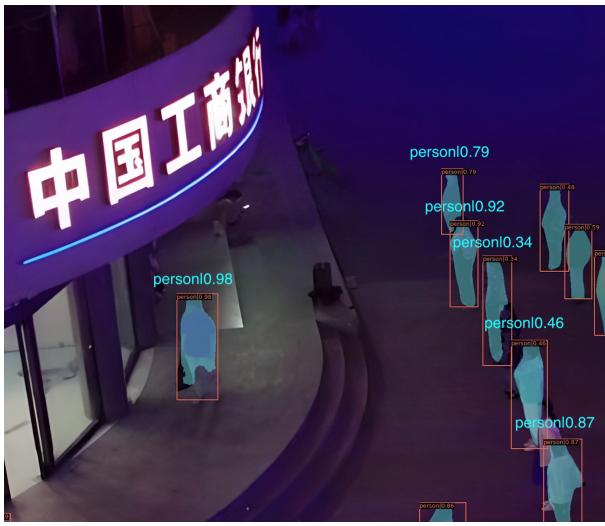
We saw slight improvements in overall object detection (as seen above, an improvement of only 2% was achieved), with some objects increasing in accuracy, but a select few objects also decreasing in accuracy. To verify that these were indeed the expected increases in accuracy due to image enhancement, we decided to follow up our object detection model with a second model, MMDetection's RCNN Mask.

6

https://tfhub.dev/google/faster_rcnn/openimages_v4/inception_resnet_v2/1



*Enhanced Frame (Real-ESRGAN)
(Accuracies Duplicated for Easy Reading)*



Once again, overall object detection confidence scores increased but not by a substantial amount. We did notice that while some objects achieved significant increases in confidence scores, others inexplicably decreased, possibly causing changes to average out and give us an overall object detection rate similar to the original images. We hypothesize that when upscaling low-resolution images or video frames, certain information and image fidelity was lost in the process that was crucial for image detection. We can see this in the generated images, where certain objects such as car tires take on a computer generated appearance, making it difficult for the model to interpret them.

2.3. Video Processing

We continued to tweak our models and apply them to new datasets. Given that our original concept revolved around surveillance footage, we decided to see how well the same procedure would perform on manual video data input. To achieve this, we created procedures to split user inputted videos into collections of individual frames, applying the exact same procedures for upscaling and object detection on every single frame as we did with the surveillance images, and then reviewing the results. We decided to go one step further and recompile the newly analyzed frames back into a downloadable video, to visualize the object detection over a live representation of the inputted video. The complete pipeline works as follows: 1. user uploads a video, 2. the video would be broken down into individual frames, 3. each frame would be upscaled and run through both Inception_ResNet_v2 and RCNN Mask, and then finally 4. recompiled into a processed video ready for download.

We believe that future work should attempt this concept with a state-of-the-art object detection model such as SWIN G++ and compare accuracy results. We expect the accuracy results to improve. Initially, we ran our video frames through the pretrained model provided by the researchers behind Real-ESRGAN just to get an idea of how the model would perform.

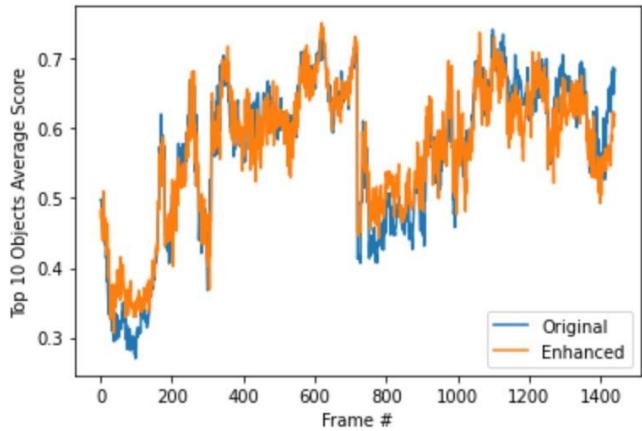
3. Results

3.1. Accuracy Results on Images

Overall, prediction did improve with enhanced images, however the effect wasn't drastic or statistically significant. Results varied heavily depending on the initial surveillance footage, be it a video input or raw dataset. Our method performed much better on color videos than on grayscale footage, and overall, the average confidence score for the top 10 objects across both

the original footage and enhanced footage tended to follow the same performance.

Results on VisDrone Dataset ($56.6\% \rightarrow 56.9\%$)



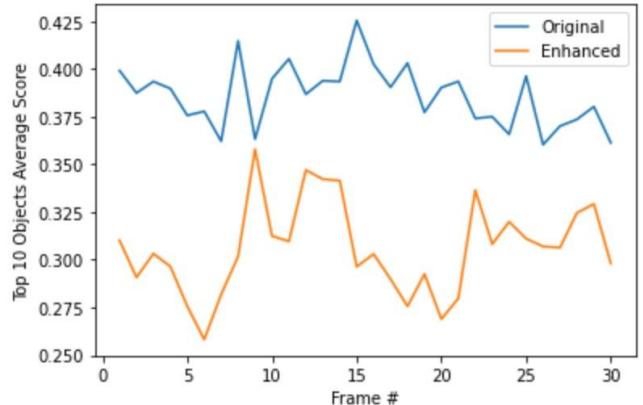
Original Footage: Average top 10 object score = 0.5660715699195862
Enhanced Footage: Average top 10 object score = 0.5691840052604675

3.2. Accuracy Results on Video

Using the same procedure on frames from surveillance videos performed very poorly. We assume that original video compression and intermediate frames already made it difficult for object detection, which when passed through enhancement, only made the image more difficult to analyze. Passing every frame through an upscaling model seemed to heavily factor in initial resolution, image dimensions and overall image fidelity - as shorter, lower quality surveillance videos interpolate between frames, often distorting important semantic content of the frames themselves.

We tested our model on short videos, consisting of only a few seconds of content. We assume that with longer and more higher resolution videos our approach would perform better, however the time required for longer video processing quickly compounds to hours, if not days of inference processing.

240p Video Test - 30 Frames ($38.5\% \rightarrow 30.5\%$)



Original Footage: Average top 10 object score = 0.38587307929992676
Enhanced Footage: Average top 10 object score = 0.3058694899082184

We noticed that detection via enhanced images oftentimes led to the detection of objects and persons that the model did not pick up in the original image. Other times, the model would also create clearer boundaries between objects of interest.

We hypothesize that the reasons for these rather subpar outcomes was due to 1. loss of crucial pixels used in detection during the processes of upscaling, as well as the 2. extremely short inputted video duration (only 30 frames). While the upscaled images were larger and provided more detail, many details from the original image were lost, either through smoothing, blurring or general geometric anomalies as seen here:



Enhanced Frame (Real-ESRGAN)

We believe future work can build upon this foundation and result in substantial improvements in average object confidence scores if detection models are retrained on the enhanced images. However, due to time constraints, we were unable to test that theory.

4. Conclusion

Our work provided some proof of concept behind our idea of improving object detection in surveillance footage. The general improvements in object detection on enhanced images have shown that it is possible to achieve better detection confidence by improving image resolution and clarity prior to running an object detection algorithm. However, it also showed the issues and shortcomings with the concept, such as loss in crucial image information during upscaling, mild image content distortion and poor detection performance on short-duration video data.

We think this concept can be improved upon if, after upscaling a dataset, the object

detection model is trained on the newly generated dataset so that it is better tailored to the smoothed out and higher resolution video frames. If this theory is proven to be correct, then future work can also include applications on live video, where video frame enhancement and per-frame object detection can occur in real-time.

5. References

- Wang, Xintao, et al. "Towards Real-World Blind Face Restoration with Generative Facial Prior." 2021 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2021, <https://doi.org/10.1109/cvpr46437.2021.00905>.
- Liang, Jingyun, et al. "Swinir: Image Restoration Using Swin Transformer." 2021 IEEE/CVF International Conference on Computer Vision Workshops (ICCVW), 2021, <https://doi.org/10.1109/iccvw54120.2021.00210>.
- TencentARC. "TENCENTARC/GFPGAN: GFPGAN Aims at Developing Practical Algorithms for Real-World Face Restoration." GitHub, <https://github.com/TencentARC/GFPGAN>.
- Xinntao. "Xinntao/Real-ESRGAN: Real-ESRGAN Aims at Developing Practical Algorithms for General Image Restoration." GitHub, <https://github.com/xinntao/Real-ESRGAN>.
- Tensorflow Hub, https://tfhub.dev/google/faster_rcnn/openimages_v4/inception_resnet_v2/1.

Code

Too much code to paste here, all of our code is available in our final project notebook, uploaded to Gradescope.

Improving Object Detection in Surveillance Footage using Real-ESRGAN and Inception_ResNet_v2

Project Group (CS-GY 6923)

- Yulian Kraynyak (yk2562@nyu.edu) [Github](#)
- Yegor Chernyshev (yc5109@nyu.edu) [Github](#)

Surveillance footage is very often recorded in extremely low quality, sacrificing resolution for file size in order to efficiently record footage for extended periods of time. This leads to messy results when attempting to later detect objects such as faces, people, cars, and more.

For our project, we attempted to improve object detection in surveillance footage by using Real-ESRGAN to enhance and upscale recorded frames, increasing their resolution and ultimately, improving the performance of object detection models.

! Execution will pause when it reaches the cell to mount the Google Drive. Please follow the instructions in the cell output. After that, feel free to set the file to run the rest of the cells autonomously. **!**

⚠️ Execution can take quite some time, please be patient when importing the necessary packages and datasets. **⚠️**

- Tiny Dataset ETA - 30 Minutes



Sources

Giving credit where credit is due. Various code snippets, samples and datasets were used from the following teams and repositories.

- Inception-ResNet_v2 [Website](#)
- Real-ESRGAN [Paper](#) | [Github](#)
- MMDetection [Github](#) | [Colab Tutorial](#)
- VisDrone [Github](#)
- Object Detection [Colab](#)

- Transfer Learning Colab

Install packages

Let's first install some required packages and define some helper functions.

Mount Drive - Holds Trained Models and Datasets

```
In [1]: # Google Drive Mount
from google.colab import drive
from google.colab import files
```

```
In [2]: # Please open the link in the output,
# and paste the code provided on that page
# in the text field in the cell output.
drive._mount('/content/drive')
```

Mounted at /content/drive

```
In [3]: import numpy as np
import matplotlib.pyplot as plt
import shutil
from shutil import copyfile
import random
import glob
import time
import cv2
import os
from operator import is_not
from IPython.display import HTML, display

import tensorflow as tf
import tensorflow_hub as hub
import tensorflow.keras.backend as K
from tensorflow.keras import applications
from tensorflow.keras import optimizers
from tensorflow.python.client import device_lib
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dropout, Flatten, Dense
from tensorflow.keras.preprocessing.image import ImageDataGenerator

# For drawing object labels after object detection
from PIL import Image
from PIL import ImageColor
from PIL import ImageDraw
from PIL import ImageFont
from PIL import ImageOps
```

```
In [4]: %%bash
MINICONDA_INSTALLER_SCRIPT=Miniconda3-4.5.4-Linux-x86_64.sh
MINICONDA_PREFIX=/usr/local
wget https://repo.continuum.io/miniconda/$MINICONDA_INSTALLER_SCRIPT
```

```
chmod +x $MINICONDA_INSTALLER_SCRIPT
./$MINICONDA_INSTALLER_SCRIPT -b -f -p $MINICONDA_PREFIX
```

```
PREFIX=/usr/local
installing: python-3.6.5-hc3d631a_2 ...
installing: ca-certificates-2018.03.07-0 ...
installing: conda-env-2.6.0-h36134e3_1 ...
installing: libgcc-ng-7.2.0-hdf63c60_3 ...
installing: libstdcxx-ng-7.2.0-hdf63c60_3 ...
installing: libffi-3.2.1-hd88cf55_4 ...
installing: ncurses-6.1-hf484d3e_0 ...
installing: openssl-1.0.2o-h20670df_0 ...
installing: tk-8.6.7-hc745277_3 ...
installing: xz-5.2.4-h14c3975_4 ...
installing: yaml-0.1.7-had09818_2 ...
installing: zlib-1.2.11-ha838bed_2 ...
installing: libedit-3.1.20170329-h6b74fdf_2 ...
installing: readline-7.0-ha6073c6_4 ...
installing: sqlite-3.23.1-he433501_0 ...
installing: asn1crypto-0.24.0-py36_0 ...
installing: certifi-2018.4.16-py36_0 ...
installing: chardet-3.0.4-py36h0f667ec_1 ...
installing: idna-2.6-py36h82fb2a8_1 ...
installing: pycosat-0.6.3-py36h0a5515d_0 ...
installing: pyparser-2.18-py36hf9f622e_1 ...
installing: pysocks-1.6.8-py36_0 ...
installing: ruamel_yaml-0.15.37-py36h14c3975_2 ...
installing: six-1.11.0-py36h372c433_1 ...
installing: cffi-1.11.5-py36h9745a5d_0 ...
installing: setuptools-39.2.0-py36_0 ...
installing: cryptography-2.2.2-py36h14c3975_0 ...
installing: wheel-0.31.1-py36_0 ...
installing: pip-10.0.1-py36_0 ...
installing: pyopenssl-18.0.0-py36_0 ...
installing: urllib3-1.22-py36hbe7ace6_0 ...
installing: requests-2.18.4-py36he2e5f8d_1 ...
installing: conda-4.5.4-py36_0 ...
installation finished.
```

WARNING:

You currently have a PYTHONPATH environment variable set. This may cause

unexpected behavior when running the Python interpreter in Miniconda3.

For best results, please verify that your PYTHONPATH only points to
directories of packages that are compatible with the Python interpreter
in Miniconda3: /usr/local

```
--2021-12-23 01:34:49-- https://repo.continuum.io/miniconda/Miniconda3-4.5.4-Linux-x86_64.sh
Resolving repo.continuum.io (repo.continuum.io)... 104.18.201.79, 104.18.200.79,
2606:4700::6812:c94f, ...
Connecting to repo.continuum.io (repo.continuum.io)|104.18.201.79|:443... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: https://repo.anaconda.com/miniconda/Miniconda3-4.5.4-Linux-x86_64.sh
[following]
--2021-12-23 01:34:50-- https://repo.anaconda.com/miniconda/Miniconda3-4.5.4-Linux-x86_64.sh
Resolving repo.anaconda.com (repo.anaconda.com)... 104.16.131.3, 104.16.130.3, 2
606:4700::6810:8303, ...
Connecting to repo.anaconda.com (repo.anaconda.com)|104.16.131.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 58468498 (56M) [application/x-sh]
Saving to: 'Miniconda3-4.5.4-Linux-x86_64.sh'
```

```
OK ..... 0% 126M 0s
```

50K	0%	6.64M	4s
100K	0%	7.13M	6s
150K	0%	100M	4s
200K	0%	87.8M	4s
250K	0%	149M	3s
300K	0%	8.09M	4s
350K	0%	178M	3s
400K	0%	110M	3s
450K	0%	123M	3s
500K	0%	105M	2s
550K	1%	306M	2s
600K	1%	145M	2s
650K	1%	123M	2s
700K	1%	166M	2s
750K	1%	120M	2s
800K	1%	12.4M	2s
850K	1%	216M	2s
900K	1%	107M	2s
950K	1%	110M	2s
1000K	1%	355M	2s
1050K	1%	100M	2s
1100K	2%	172M	2s
1150K	2%	102M	1s
1200K	2%	131M	1s
1250K	2%	132M	1s
1300K	2%	313M	1s
1350K	2%	113M	1s
1400K	2%	124M	1s
1450K	2%	117M	1s
1500K	2%	344M	1s
1550K	2%	151M	1s
1600K	2%	146M	1s
1650K	2%	28.0M	1s
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1800K	3%	295M	1s
1850K	3%	205M	1s
1900K	3%	173M	1s
1950K	3%	208M	1s
2000K	3%	221M	1s
2050K	3%	218M	1s
2100K	3%	180M	1s
2150K	3%	231M	1s
2200K	3%	305M	1s
2250K	4%	196M	1s
2300K	4%	199M	1s
2350K	4%	226M	1s
2400K	4%	142M	1s
2450K	4%	344M	1s
2500K	4%	280M	1s
2550K	4%	300M	1s
2600K	4%	184M	1s
2650K	4%	377M	1s
2700K	4%	198M	1s
2750K	4%	265M	1s
2800K	4%	265M	1s
2850K	5%	240M	1s
2900K	5%	218M	1s
2950K	5%	307M	1s
3000K	5%	261M	1s
3050K	5%	203M	1s
3100K	5%	232M	1s
3150K	5%	211M	1s
3200K	5%	339M	1s
3250K	5%	175M	1s

3300K	5%	146M	1s
3350K	5%	285M	1s
3400K	6%	362M	1s
3450K	6%	328M	1s
3500K	6%	367M	1s
3550K	6%	296M	1s
3600K	6%	370M	1s
3650K	6%	345M	1s
3700K	6%	362M	1s
3750K	6%	283M	1s
3800K	6%	341M	1s
3850K	6%	350M	1s
3900K	6%	354M	1s
3950K	7%	281M	1s
4000K	7%	344M	1s
4050K	7%	352M	1s
4100K	7%	333M	1s
4150K	7%	311M	1s
4200K	7%	366M	1s
4250K	7%	324M	1s
4300K	7%	376M	1s
4350K	7%	297M	1s
4400K	7%	355M	1s
4450K	7%	361M	1s
4500K	7%	350M	1s
4550K	8%	307M	1s
4600K	8%	340M	1s
4650K	8%	313M	1s
4700K	8%	362M	1s
4750K	8%	278M	1s
4800K	8%	331M	1s
4850K	8%	366M	1s
4900K	8%	337M	1s
4950K	8%	322M	1s
5000K	8%	336M	1s
5050K	8%	366M	0s
5100K	9%	359M	0s
5150K	9%	270M	0s
5200K	9%	339M	0s
5250K	9%	321M	0s
5300K	9%	348M	0s
5350K	9%	311M	0s
5400K	9%	358M	0s
5450K	9%	337M	0s
5500K	9%	305M	0s
5550K	9%	268M	0s
5600K	9%	328M	0s
5650K	9%	358M	0s
5700K	10%	365M	0s
5750K	10%	329M	0s
5800K	10%	347M	0s
5850K	10%	355M	0s
5900K	10%	330M	0s
5950K	10%	296M	0s
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6050K	10%	342M	0s
6100K	10%	374M	0s
6150K	10%	299M	0s
6200K	10%	379M	0s
6250K	11%	352M	0s
6300K	11%	385M	0s
6350K	11%	301M	0s
6400K	11%	378M	0s
6450K	11%	341M	0s
6500K	11%	313M	0s

6550K	11%	326M	0s
6600K	11%	369M	0s
6650K	11%	363M	0s
6700K	11%	333M	0s
6750K	11%	309M	0s
6800K	11%	388M	0s
6850K	12%	346M	0s
6900K	12%	368M	0s
6950K	12%	260M	0s
7000K	12%	348M	0s
7050K	12%	377M	0s
7100K	12%	333M	0s
7150K	12%	272M	0s
7200K	12%	337M	0s
7250K	12%	351M	0s
7300K	12%	345M	0s
7350K	12%	295M	0s
7400K	13%	355M	0s
7450K	13%	337M	0s
7500K	13%	330M	0s
7550K	13%	284M	0s
7600K	13%	363M	0s
7650K	13%	336M	0s
7700K	13%	320M	0s
7750K	13%	309M	0s
7800K	13%	354M	0s
7850K	13%	334M	0s
7900K	13%	344M	0s
7950K	14%	294M	0s
8000K	14%	328M	0s
8050K	14%	350M	0s
8100K	14%	354M	0s
8150K	14%	323M	0s
8200K	14%	338M	0s
8250K	14%	381M	0s
8300K	14%	362M	0s
8350K	14%	294M	0s
8400K	14%	383M	0s
8450K	14%	352M	0s
8500K	14%	358M	0s
8550K	15%	299M	0s
8600K	15%	379M	0s
8650K	15%	373M	0s
8700K	15%	364M	0s
8750K	15%	298M	0s
8800K	15%	364M	0s
8850K	15%	373M	0s
8900K	15%	361M	0s
8950K	15%	325M	0s
9000K	15%	379M	0s
9050K	15%	362M	0s
9100K	16%	384M	0s
9150K	16%	322M	0s
9200K	16%	372M	0s
9250K	16%	366M	0s
9300K	16%	349M	0s
9350K	16%	337M	0s
9400K	16%	375M	0s
9450K	16%	383M	0s
9500K	16%	377M	0s
9550K	16%	321M	0s
9600K	16%	382M	0s
9650K	16%	331M	0s
9700K	17%	366M	0s
9750K	17%	318M	0s

9800K	17%	239M	0s
9850K	17%	363M	0s
9900K	17%	283M	0s
9950K	17%	245M	0s
10000K	17%	313M	0s
10050K	17%	326M	0s
10100K	17%	309M	0s
10150K	17%	292M	0s
10200K	17%	336M	0s
10250K	18%	347M	0s
10300K	18%	343M	0s
10350K	18%	296M	0s
10400K	18%	331M	0s
10450K	18%	362M	0s
10500K	18%	373M	0s
10550K	18%	303M	0s
10600K	18%	286M	0s
10650K	18%	372M	0s
10700K	18%	378M	0s
10750K	18%	289M	0s
10800K	19%	347M	0s
10850K	19%	380M	0s
10900K	19%	376M	0s
10950K	19%	284M	0s
11000K	19%	363M	0s
11050K	19%	379M	0s
11100K	19%	366M	0s
11150K	19%	320M	0s
11200K	19%	381M	0s
11250K	19%	378M	0s
11300K	19%	360M	0s
11350K	19%	324M	0s
11400K	20%	380M	0s
11450K	20%	365M	0s
11500K	20%	381M	0s
11550K	20%	322M	0s
11600K	20%	378M	0s
11650K	20%	383M	0s
11700K	20%	26.3M	0s
11750K	20%	292M	0s
11800K	20%	319M	0s
11850K	20%	334M	0s
11900K	20%	348M	0s
11950K	21%	294M	0s
12000K	21%	358M	0s
12050K	21%	377M	0s
12100K	21%	339M	0s
12150K	21%	308M	0s
12200K	21%	377M	0s
12250K	21%	331M	0s
12300K	21%	215M	0s
12350K	21%	187M	0s
12400K	21%	239M	0s
12450K	21%	262M	0s
12500K	21%	253M	0s
12550K	22%	229M	0s
12600K	22%	222M	0s
12650K	22%	218M	0s
12700K	22%	207M	0s
12750K	22%	195M	0s
12800K	22%	210M	0s
12850K	22%	218M	0s
12900K	22%	201M	0s
12950K	22%	213M	0s
13000K	22%	230M	0s

16300K	28%	358M	0s
16350K	28%	277M	0s
16400K	28%	331M	0s
16450K	28%	334M	0s
16500K	28%	304M	0s
16550K	29%	292M	0s
16600K	29%	342M	0s
16650K	29%	349M	0s
16700K	29%	375M	0s
16750K	29%	267M	0s
16800K	29%	345M	0s
16850K	29%	344M	0s
16900K	29%	313M	0s
16950K	29%	329M	0s
17000K	29%	382M	0s
17050K	29%	378M	0s
17100K	30%	370M	0s
17150K	30%	302M	0s
17200K	30%	380M	0s
17250K	30%	390M	0s
17300K	30%	357M	0s
17350K	30%	329M	0s
17400K	30%	375M	0s
17450K	30%	387M	0s
17500K	30%	381M	0s
17550K	30%	288M	0s
17600K	30%	381M	0s
17650K	30%	370M	0s
17700K	31%	377M	0s
17750K	31%	341M	0s
17800K	31%	384M	0s
17850K	31%	375M	0s
17900K	31%	322M	0s
17950K	31%	313M	0s
18000K	31%	368M	0s
18050K	31%	382M	0s
18100K	31%	377M	0s
18150K	31%	334M	0s
18200K	31%	327M	0s
18250K	32%	327M	0s
18300K	32%	341M	0s
18350K	32%	266M	0s
18400K	32%	379M	0s
18450K	32%	380M	0s
18500K	32%	379M	0s
18550K	32%	328M	0s
18600K	32%	307M	0s
18650K	32%	377M	0s
18700K	32%	360M	0s
18750K	32%	94.2M	0s
18800K	33%	316M	0s
18850K	33%	319M	0s
18900K	33%	344M	0s
18950K	33%	295M	0s
19000K	33%	337M	0s
19050K	33%	362M	0s
19100K	33%	342M	0s
19150K	33%	286M	0s
19200K	33%	361M	0s
19250K	33%	340M	0s
19300K	33%	333M	0s
19350K	33%	310M	0s
19400K	34%	351M	0s
19450K	34%	353M	0s
19500K	34%	321M	0s

19550K	34%	306M	0s
19600K	34%	356M	0s
19650K	34%	351M	0s
19700K	34%	363M	0s
19750K	34%	304M	0s
19800K	34%	362M	0s
19850K	34%	322M	0s
19900K	34%	372M	0s
19950K	35%	294M	0s
20000K	35%	385M	0s
20050K	35%	381M	0s
20100K	35%	376M	0s
20150K	35%	339M	0s
20200K	35%	322M	0s
20250K	35%	383M	0s
20300K	35%	368M	0s
20350K	35%	318M	0s
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20450K	35%	390M	0s
20500K	35%	148M	0s
20550K	36%	298M	0s
20600K	36%	309M	0s
20650K	36%	327M	0s
20700K	36%	333M	0s
20750K	36%	303M	0s
20800K	36%	387M	0s
20850K	36%	352M	0s
20900K	36%	355M	0s
20950K	36%	301M	0s
21000K	36%	370M	0s
21050K	36%	365M	0s
21100K	37%	340M	0s
21150K	37%	303M	0s
21200K	37%	351M	0s
21250K	37%	342M	0s
21300K	37%	332M	0s
21350K	37%	324M	0s
21400K	37%	353M	0s
21450K	37%	344M	0s
21500K	37%	358M	0s
21550K	37%	289M	0s
21600K	37%	333M	0s
21650K	38%	361M	0s
21700K	38%	358M	0s
21750K	38%	298M	0s
21800K	38%	374M	0s
21850K	38%	374M	0s
21900K	38%	348M	0s
21950K	38%	313M	0s
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22150K	38%	327M	0s
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22250K	39%	362M	0s
22300K	39%	356M	0s
22350K	39%	309M	0s
22400K	39%	371M	0s
22450K	39%	386M	0s
22500K	39%	383M	0s
22550K	39%	335M	0s
22600K	39%	364M	0s
22650K	39%	376M	0s
22700K	39%	361M	0s
22750K	39%	314M	0s

22800K	40%	388M	0s
22850K	40%	386M	0s
22900K	40%	381M	0s
22950K	40%	329M	0s
23000K	40%	359M	0s
23050K	40%	360M	0s
23100K	40%	297M	0s
23150K	40%	293M	0s
23200K	40%	359M	0s
23250K	40%	378M	0s
23300K	40%	359M	0s
23350K	40%	340M	0s
23400K	41%	381M	0s
23450K	41%	375M	0s
23500K	41%	384M	0s
23550K	41%	30.6M	0s
23600K	41%	339M	0s
23650K	41%	303M	0s
23700K	41%	375M	0s
23750K	41%	335M	0s
23800K	41%	345M	0s
23850K	41%	310M	0s
23900K	41%	354M	0s
23950K	42%	295M	0s
24000K	42%	354M	0s
24050K	42%	376M	0s
24100K	42%	376M	0s
24150K	42%	322M	0s
24200K	42%	326M	0s
24250K	42%	338M	0s
24300K	42%	366M	0s
24350K	42%	230M	0s
24400K	42%	353M	0s
24450K	42%	366M	0s
24500K	42%	345M	0s
24550K	43%	299M	0s
24600K	43%	363M	0s
24650K	43%	294M	0s
24700K	43%	368M	0s
24750K	43%	320M	0s
24800K	43%	391M	0s
24850K	43%	348M	0s
24900K	43%	316M	0s
24950K	43%	314M	0s
25000K	43%	350M	0s
25050K	43%	344M	0s
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25150K	44%	284M	0s
25200K	44%	319M	0s
25250K	44%	357M	0s
25300K	44%	362M	0s
25350K	44%	297M	0s
25400K	44%	342M	0s
25450K	44%	334M	0s
25500K	44%	361M	0s
25550K	44%	282M	0s
25600K	44%	368M	0s
25650K	45%	374M	0s
25700K	45%	363M	0s
25750K	45%	341M	0s
25800K	45%	375M	0s
25850K	45%	390M	0s
25900K	45%	386M	0s
25950K	45%	254M	0s
26000K	45%	354M	0s

26050K	45%	336M	0s
26100K	45%	369M	0s
26150K	45%	311M	0s
26200K	45%	342M	0s
26250K	46%	343M	0s
26300K	46%	370M	0s
26350K	46%	319M	0s
26400K	46%	368M	0s
26450K	46%	385M	0s
26500K	46%	390M	0s
26550K	46%	344M	0s
26600K	46%	379M	0s
26650K	46%	357M	0s
26700K	46%	376M	0s
26750K	46%	306M	0s
26800K	47%	46.2M	0s
26850K	47%	360M	0s
26900K	47%	327M	0s
26950K	47%	309M	0s
27000K	47%	333M	0s
27050K	47%	373M	0s
27100K	47%	388M	0s
27150K	47%	302M	0s
27200K	47%	340M	0s
27250K	47%	378M	0s
27300K	47%	361M	0s
27350K	47%	306M	0s
27400K	48%	361M	0s
27450K	48%	382M	0s
27500K	48%	377M	0s
27550K	48%	291M	0s
27600K	48%	352M	0s
27650K	48%	384M	0s
27700K	48%	140M	0s
27750K	48%	301M	0s
27800K	48%	351M	0s
27850K	48%	339M	0s
27900K	48%	345M	0s
27950K	49%	297M	0s
28000K	49%	337M	0s
28050K	49%	354M	0s
28100K	49%	339M	0s
28150K	49%	324M	0s
28200K	49%	351M	0s
28250K	49%	379M	0s
28300K	49%	328M	0s
28350K	49%	303M	0s
28400K	49%	346M	0s
28450K	49%	322M	0s
28500K	50%	371M	0s
28550K	50%	329M	0s
28600K	50%	362M	0s
28650K	50%	369M	0s
28700K	50%	320M	0s
28750K	50%	300M	0s
28800K	50%	345M	0s
28850K	50%	369M	0s
28900K	50%	364M	0s
28950K	50%	327M	0s
29000K	50%	388M	0s
29050K	50%	366M	0s
29100K	51%	381M	0s
29150K	51%	311M	0s
29200K	51%	362M	0s
29250K	51%	372M	0s

29300K	51%	348M	0s
29350K	51%	288M	0s
29400K	51%	304M	0s
29450K	51%	342M	0s
29500K	51%	344M	0s
29550K	51%	239M	0s
29600K	51%	315M	0s
29650K	52%	273M	0s
29700K	52%	211M	0s
29750K	52%	213M	0s
29800K	52%	213M	0s
29850K	52%	219M	0s
29900K	52%	220M	0s
29950K	52%	173M	0s
30000K	52%	185M	0s
30050K	52%	189M	0s
30100K	52%	197M	0s
30150K	52%	234M	0s
30200K	52%	284M	0s
30250K	53%	389M	0s
30300K	53%	388M	0s
30350K	53%	275M	0s
30400K	53%	321M	0s
30450K	53%	357M	0s
30500K	53%	366M	0s
30550K	53%	342M	0s
30600K	53%	339M	0s
30650K	53%	363M	0s
30700K	53%	301M	0s
30750K	53%	150M	0s
30800K	54%	195M	0s
30850K	54%	232M	0s
30900K	54%	337M	0s
30950K	54%	262M	0s
31000K	54%	206M	0s
31050K	54%	251M	0s
31100K	54%	325M	0s
31150K	54%	296M	0s
31200K	54%	313M	0s
31250K	54%	231M	0s
31300K	54%	235M	0s
31350K	54%	179M	0s
31400K	55%	223M	0s
31450K	55%	222M	0s
31500K	55%	220M	0s
31550K	55%	179M	0s
31600K	55%	259M	0s
31650K	55%	313M	0s
31700K	55%	344M	0s
31750K	55%	355M	0s
31800K	55%	426M	0s
31850K	55%	337M	0s
31900K	55%	397M	0s
31950K	56%	275M	0s
32000K	56%	385M	0s
32050K	56%	287M	0s
32100K	56%	247M	0s
32150K	56%	185M	0s
32200K	56%	212M	0s
32250K	56%	218M	0s
32300K	56%	200M	0s
32350K	56%	175M	0s
32400K	56%	214M	0s
32450K	56%	218M	0s
32500K	57%	210M	0s

32550K	57%	182M	0s
32600K	57%	232M	0s
32650K	57%	222M	0s
32700K	57%	203M	0s
32750K	57%	194M	0s
32800K	57%	224M	0s
32850K	57%	207M	0s
32900K	57%	232M	0s
32950K	57%	222M	0s
33000K	57%	205M	0s
33050K	57%	236M	0s
33100K	58%	242M	0s
33150K	58%	200M	0s
33200K	58%	255M	0s
33250K	58%	254M	0s
33300K	58%	222M	0s
33350K	58%	220M	0s
33400K	58%	224M	0s
33450K	58%	238M	0s
33500K	58%	233M	0s
33550K	58%	206M	0s
33600K	58%	207M	0s
33650K	59%	229M	0s
33700K	59%	240M	0s
33750K	59%	215M	0s
33800K	59%	236M	0s
33850K	59%	223M	0s
33900K	59%	216M	0s
33950K	59%	184M	0s
34000K	59%	242M	0s
34050K	59%	219M	0s
34100K	59%	256M	0s
34150K	59%	207M	0s
34200K	59%	227M	0s
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34350K	60%	213M	0s
34400K	60%	233M	0s
34450K	60%	236M	0s
34500K	60%	220M	0s
34550K	60%	194M	0s
34600K	60%	255M	0s
34650K	60%	233M	0s
34700K	60%	259M	0s
34750K	60%	203M	0s
34800K	61%	258M	0s
34850K	61%	160M	0s
34900K	61%	238M	0s
34950K	61%	226M	0s
35000K	61%	173M	0s
35050K	61%	190M	0s
35100K	61%	211M	0s
35150K	61%	181M	0s
35200K	61%	200M	0s
35250K	61%	211M	0s
35300K	61%	219M	0s
35350K	61%	147M	0s
35400K	62%	236M	0s
35450K	62%	203M	0s
35500K	62%	209M	0s
35550K	62%	204M	0s
35600K	62%	233M	0s
35650K	62%	218M	0s
35700K	62%	216M	0s
35750K	62%	225M	0s

35800K	62%	232M	0s
35850K	62%	259M	0s
35900K	62%	251M	0s
35950K	63%	199M	0s
36000K	63%	220M	0s
36050K	63%	217M	0s
36100K	63%	234M	0s
36150K	63%	226M	0s
36200K	63%	262M	0s
36250K	63%	260M	0s
36300K	63%	218M	0s
36350K	63%	191M	0s
36400K	63%	263M	0s
36450K	63%	259M	0s
36500K	64%	255M	0s
36550K	64%	218M	0s
36600K	64%	223M	0s
36650K	64%	221M	0s
36700K	64%	228M	0s
36750K	64%	194M	0s
36800K	64%	253M	0s
36850K	64%	252M	0s
36900K	64%	257M	0s
36950K	64%	229M	0s
37000K	64%	240M	0s
37050K	64%	258M	0s
37100K	65%	244M	0s
37150K	65%	194M	0s
37200K	65%	247M	0s
37250K	65%	234M	0s
37300K	65%	236M	0s
37350K	65%	186M	0s
37400K	65%	207M	0s
37450K	65%	236M	0s
37500K	65%	214M	0s
37550K	65%	176M	0s
37600K	65%	237M	0s
37650K	66%	223M	0s
37700K	66%	225M	0s
37750K	66%	221M	0s
37800K	66%	239M	0s
37850K	66%	248M	0s
37900K	66%	257M	0s
37950K	66%	214M	0s
38000K	66%	220M	0s
38050K	66%	257M	0s
38100K	66%	261M	0s
38150K	66%	220M	0s
38200K	66%	260M	0s
38250K	67%	255M	0s
38300K	67%	234M	0s
38350K	67%	194M	0s
38400K	67%	216M	0s
38450K	67%	214M	0s
38500K	67%	220M	0s
38550K	67%	203M	0s
38600K	67%	235M	0s
38650K	67%	240M	0s
38700K	67%	241M	0s
38750K	67%	207M	0s
38800K	68%	230M	0s
38850K	68%	218M	0s
38900K	68%	259M	0s
38950K	68%	225M	0s
39000K	68%	201M	0s

39050K	68%	212M	0s
39100K	68%	183M	0s
39150K	68%	198M	0s
39200K	68%	229M	0s
39250K	68%	234M	0s
39300K	68%	200M	0s
39350K	69%	204M	0s
39400K	69%	247M	0s
39450K	69%	215M	0s
39500K	69%	224M	0s
39550K	69%	186M	0s
39600K	69%	209M	0s
39650K	69%	234M	0s
39700K	69%	240M	0s
39750K	69%	217M	0s
39800K	69%	245M	0s
39850K	69%	255M	0s
39900K	69%	261M	0s
39950K	70%	193M	0s
40000K	70%	231M	0s
40050K	70%	223M	0s
40100K	70%	241M	0s
40150K	70%	202M	0s
40200K	70%	234M	0s
40250K	70%	260M	0s
40300K	70%	249M	0s
40350K	70%	214M	0s
40400K	70%	264M	0s
40450K	70%	244M	0s
40500K	71%	258M	0s
40550K	71%	223M	0s
40600K	71%	233M	0s
40650K	71%	225M	0s
40700K	71%	219M	0s
40750K	71%	153M	0s
40800K	71%	236M	0s
40850K	71%	223M	0s
40900K	71%	203M	0s
40950K	71%	176M	0s
41000K	71%	215M	0s
41050K	71%	216M	0s
41100K	72%	211M	0s
41150K	72%	173M	0s
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41250K	72%	253M	0s
41300K	72%	225M	0s
41350K	72%	212M	0s
41400K	72%	239M	0s
41450K	72%	262M	0s
41500K	72%	258M	0s
41550K	72%	205M	0s
41600K	72%	232M	0s
41650K	73%	238M	0s
41700K	73%	256M	0s
41750K	73%	213M	0s
41800K	73%	234M	0s
41850K	73%	263M	0s
41900K	73%	231M	0s
41950K	73%	218M	0s
42000K	73%	265M	0s
42050K	73%	243M	0s
42100K	73%	255M	0s
42150K	73%	221M	0s
42200K	73%	259M	0s
42250K	74%	225M	0s

42300K	74%	210M	0s
42350K	74%	210M	0s
42400K	74%	232M	0s
42450K	74%	263M	0s
42500K	74%	219M	0s
42550K	74%	194M	0s
42600K	74%	249M	0s
42650K	74%	258M	0s
42700K	74%	235M	0s
42750K	74%	192M	0s
42800K	75%	257M	0s
42850K	75%	236M	0s
42900K	75%	234M	0s
42950K	75%	210M	0s
43000K	75%	237M	0s
43050K	75%	225M	0s
43100K	75%	235M	0s
43150K	75%	207M	0s
43200K	75%	248M	0s
43250K	75%	259M	0s
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43450K	76%	244M	0s
43500K	76%	232M	0s
43550K	76%	195M	0s
43600K	76%	262M	0s
43650K	76%	261M	0s
43700K	76%	249M	0s
43750K	76%	226M	0s
43800K	76%	248M	0s
43850K	76%	264M	0s
43900K	76%	260M	0s
43950K	77%	210M	0s
44000K	77%	212M	0s
44050K	77%	218M	0s
44100K	77%	256M	0s
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44450K	77%	213M	0s
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44550K	78%	215M	0s
44600K	78%	225M	0s
44650K	78%	239M	0s
44700K	78%	217M	0s
44750K	78%	219M	0s
44800K	78%	254M	0s
44850K	78%	236M	0s
44900K	78%	254M	0s
44950K	78%	222M	0s
45000K	78%	226M	0s
45050K	78%	238M	0s
45100K	79%	241M	0s
45150K	79%	217M	0s
45200K	79%	224M	0s
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45300K	79%	259M	0s
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45400K	79%	262M	0s
45450K	79%	250M	0s
45500K	79%	254M	0s

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45600K	79%	245M	0s
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45700K	80%	255M	0s
45750K	80%	235M	0s
45800K	80%	260M	0s
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45900K	80%	261M	0s
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46100K	80%	241M	0s
46150K	80%	229M	0s
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46250K	81%	262M	0s
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46950K	82%	277M	0s
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47050K	82%	236M	0s
47100K	82%	324M	0s
47150K	82%	230M	0s
47200K	82%	269M	0s
47250K	82%	243M	0s
47300K	82%	271M	0s
47350K	83%	230M	0s
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47650K	83%	304M	0s
47700K	83%	286M	0s
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47900K	83%	239M	0s
47950K	84%	191M	0s
48000K	84%	239M	0s
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48350K	84%	241M	0s
48400K	84%	315M	0s
48450K	84%	323M	0s
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48550K	85%	234M	0s
48600K	85%	263M	0s
48650K	85%	265M	0s
48700K	85%	296M	0s
48750K	85%	260M	0s

48800K	85%	255M	0s
48850K	85%	199M	0s
48900K	85%	284M	0s
48950K	85%	292M	0s
49000K	85%	366M	0s
49050K	85%	393M	0s
49100K	86%	403M	0s
49150K	86%	268M	0s
49200K	86%	208M	0s
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49550K	86%	180M	0s
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49700K	87%	217M	0s
49750K	87%	230M	0s
49800K	87%	261M	0s
49850K	87%	244M	0s
49900K	87%	247M	0s
49950K	87%	204M	0s
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50150K	87%	322M	0s
50200K	88%	288M	0s
50250K	88%	303M	0s
50300K	88%	345M	0s
50350K	88%	342M	0s
50400K	88%	269M	0s
50450K	88%	288M	0s
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50800K	89%	361M	0s
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50950K	89%	236M	0s
51000K	89%	268M	0s
51050K	89%	250M	0s
51100K	89%	261M	0s
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51250K	89%	249M	0s
51300K	89%	254M	0s
51350K	90%	10.9M	0s
51400K	90%	212M	0s
51450K	90%	231M	0s
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51600K	90%	227M	0s
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51900K	90%	234M	0s
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52250K	91%	238M	0s
52300K	91%	242M	0s
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52450K	91%	252M	0s
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52550K	92%	232M	0s
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53500K	93%	223M	0s
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53700K	94%	245M	0s
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53800K	94%	223M	0s
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54250K	95%	261M	0s
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54450K	95%	238M	0s
54500K	95%	254M	0s
54550K	95%	225M	0s
54600K	95%	263M	0s
54650K	95%	263M	0s
54700K	95%	241M	0s
54750K	95%	182M	0s
54800K	96%	256M	0s
54850K	96%	262M	0s
54900K	96%	258M	0s
54950K	96%	197M	0s
55000K	96%	223M	0s
55050K	96%	243M	0s
55100K	96%	257M	0s
55150K	96%	203M	0s
55200K	96%	258M	0s
55250K	96%	256M	0s

55300K	96%	210M	0s
55350K	97%	196M	0s
55400K	97%	207M	0s
55450K	97%	233M	0s
55500K	97%	220M	0s
55550K	97%	188M	0s
55600K	97%	227M	0s
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55700K	97%	223M	0s
55750K	97%	217M	0s
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56450K	98%	253M	0s
56500K	99%	259M	0s
56550K	99%	229M	0s
56600K	99%	250M	0s
56650K	99%	256M	0s
56700K	99%	251M	0s
56750K	99%	219M	0s
56800K	99%	269M	0s
56850K	99%	244M	0s
56900K	99%	263M	0s
56950K	99%	227M	0s
57000K	99%	262M	0s
57050K	100%	257M=0.2s	

2021-12-23 01:34:50 (225 MB/s) - 'Miniconda3-4.5.4-Linux-x86_64.sh' saved [58468 498/58468498]

Python 3.6.5 :: Anaconda, Inc.

In [5]::

```
%%bash
conda install --channel defaults conda --yes
conda update --channel defaults --all --yes
!conda --version
!python --version
```

Solving environment: ...working... done

Package Plan

environment location: /usr/local

added / updated specs:
- conda

The following packages will be downloaded:

package	build	
cffi-1.15.0	py37h7f8727e_0	224 KB
cryptography-36.0.0	py37h9ce1e76_0	1.5 MB

ML_Project		
ca-certificates-2021.10.26	h06a4308_2	121 KB
ruamel_yaml-0.15.100	py37h27cf23_0	267 KB
zlib-1.2.11	h7f8727e_4	125 KB
conda-4.11.0	py37h06a4308_0	16.9 MB
readline-7.0	h7b6447c_5	392 KB
brotlipy-0.7.0	py37h27cf23_1003	350 KB
yaml-0.2.5	h7b6447c_0	87 KB
pycparser-2.21	pyhd3eb1b0_0	94 KB
ncurses-6.3	h7f8727e_2	1.0 MB
pycosat-0.6.3	py37h27cf23_0	108 KB
libedit-3.1.20210910	h7f8727e_0	191 KB
urllib3-1.26.7	pyhd3eb1b0_0	104 KB
pyopenssl-21.0.0	pyhd3eb1b0_1	48 KB
setuptools-58.0.4	py37h06a4308_0	979 KB
pip-21.2.2	py37h06a4308_0	2.0 MB
tk-8.6.11	h1ccaba5_0	3.2 MB
idna-3.3	pyhd3eb1b0_0	55 KB
certifi-2021.10.8	py37h06a4308_0	154 KB
conda-package-handling-1.7.3	py37h27cf23_1	962 KB
pysocks-1.7.1	py37_1	27 KB
six-1.16.0	pyhd3eb1b0_0	18 KB
requests-2.26.0	pyhd3eb1b0_0	59 KB
_libgcc_mutex-0.1	main	3 KB
tqdm-4.62.3	pyhd3eb1b0_1	79 KB
xz-5.2.5	h7b6447c_0	438 KB
sqlite-3.33.0	h62c20be_0	2.0 MB
wheel-0.37.0	pyhd3eb1b0_1	31 KB
charset-normalizer-2.0.4	pyhd3eb1b0_0	33 KB
python-3.7.0	hc3d631a_0	31.7 MB
openssl-1.0.2u	h7b6447c_0	3.1 MB
libgcc-ng-9.1.0	hdf63c60_0	8.1 MB
<hr/>		
Total:		74.6 MB

The following NEW packages will be INSTALLED:

_libgcc_mutex:	0.1-main
brotlipy:	0.7.0-py37h27cf23_1003
charset-normalizer:	2.0.4-pyhd3eb1b0_0
conda-package-handling:	1.7.3-py37h27cf23_1
tqdm:	4.62.3-pyhd3eb1b0_1

The following packages will be UPDATED:

ca-certificates:	2018.03.07-0	--> 2021.10.26-h06a4308_2
certifi:	2018.4.16-py36_0	--> 2021.10.8-py37h06a4308_0
ffi:	1.11.5-py36h9745a5d_0	--> 1.15.0-py37h7f8727e_0
conda:	4.5.4-py36_0	--> 4.11.0-py37h06a4308_0
cryptography:	2.2.2-py36h14c3975_0	--> 36.0.0-py37h9ce1e76_0
idna:	2.6-py36h82fb2a8_1	--> 3.3-pyhd3eb1b0_0
libedit:	3.1.20170329-h6b74fdf_2	--> 3.1.20210910-h7f8727e_0
libgcc-ng:	7.2.0-hdf63c60_3	--> 9.1.0-hdf63c60_0
ncurses:	6.1-hf484d3e_0	--> 6.3-h7f8727e_2
openssl:	1.0.2o-h20670df_0	--> 1.0.2u-h7b6447c_0
pip:	10.0.1-py36_0	--> 21.2.2-py37h06a4308_0
pycosat:	0.6.3-py36h0a5515d_0	--> 0.6.3-py37h27cf23_0
pycparser:	2.18-py36hf9f622e_1	--> 2.21-pyhd3eb1b0_0
pyopenssl:	18.0.0-py36_0	--> 21.0.0-pyhd3eb1b0_1
pysocks:	1.6.8-py36_0	--> 1.7.1-py37_1
python:	3.6.5-hc3d631a_2	--> 3.7.0-hc3d631a_0
readline:	7.0-ha6073c6_4	--> 7.0-h7b6447c_5
requests:	2.18.4-py36he2e5f8d_1	--> 2.26.0-pyhd3eb1b0_0
ruamel_yaml:	0.15.37-py36h14c3975_2	--> 0.15.100-py37h27cf23_0
setuptools:	39.2.0-py36_0	--> 58.0.4-py37h06a4308_0
six:	1.11.0-py36h372c433_1	--> 1.16.0-pyhd3eb1b0_0

sqlite:	3.23.1-he433501_0	--> 3.33.0-h62c20be_0
tk:	8.6.7-hc745277_3	--> 8.6.11-h1ccaba5_0
urllib3:	1.22-py36hbe7ace6_0	--> 1.26.7-pyhd3eb1b0_0
wheel:	0.31.1-py36_0	--> 0.37.0-pyhd3eb1b0_1
xz:	5.2.4-h14c3975_4	--> 5.2.5-h7b6447c_0
yaml:	0.1.7-had09818_2	--> 0.2.5-h7b6447c_0
zlib:	1.2.11-ha838bed_2	--> 1.2.11-h7f8727e_4

Downloading and Extracting Packages
 Preparing transaction: ...working... done
 Verifying transaction: ...working... done
 Executing transaction: ...working... done
 Collecting package metadata (current_repodata.json): ...working... done
 Solving environment: ...working... done

Package Plan

environment location: /usr/local

The following packages will be downloaded:

package	build	
_openmp_mutex-4.5	1_gnu	22 KB
cffi-1.14.6	py37h400218f_0	223 KB
ld_impl_linux-64-2.35.1	h7274673_9	586 KB
libffi-3.3	he6710b0_2	50 KB
libgcc-ng-9.3.0	h5101ec6_17	4.8 MB
libgomp-9.3.0	h5101ec6_17	311 KB
libstdcxx-ng-9.3.0	hd4cf53a_17	3.1 MB
openssl-1.1.1l	h7f8727e_0	2.5 MB
python-3.7.11	h12debd9_0	45.3 MB
readline-8.1	h27cfcd23_0	362 KB
sqlite-3.36.0	hc218d9a_0	990 KB
<hr/>		
		Total: 58.2 MB

The following NEW packages will be INSTALLED:

_openmp_mutex	pkgs/main/linux-64::_openmp_mutex-4.5-1_gnu
ld_impl_linux-64	pkgs/main/linux-64::ld_impl_linux-64-2.35.1-h7274673_9
libgomp	pkgs/main/linux-64::libgomp-9.3.0-h5101ec6_17

The following packages will be UPDATED:

7	libffi	3.2.1-hd88cf55_4 --> 3.3-he6710b0_2
7	libgcc-ng	9.1.0-hdf63c60_0 --> 9.3.0-h5101ec6_1
0	libstdcxx-ng	7.2.0-hdf63c60_3 --> 9.3.0-hd4cf53a_1
0	openssl	1.0.2u-h7b6447c_0 --> 1.1.1l-h7f8727e_
0	python	3.7.0-hc3d631a_0 --> 3.7.11-h12debd9_
0	readline	7.0-h7b6447c_5 --> 8.1-h27cfcd23_0
0	sqlite	3.33.0-h62c20be_0 --> 3.36.0-hc218d9a_

The following packages will be DOWNGRADED:

cffi	1.15.0-py37h7f8727e_0 --> 1.14.6-py37h4002
18f_0	

```
Downloading and Extracting Packages
libgcc-ng-9.3.0      4.8 MB   #####          100%
libffi-3.3            50 KB    #####          100%
sqlite-3.36.0         990 KB   #####          100%
libstdcxx-ng-9.3.0    3.1 MB   #####          100%
readline-8.1           362 KB   #####          100%
cffi-1.14.6           223 KB   #####          100%
openssl-1.1.11        2.5 MB   #####          100%
python-3.7.11          45.3 MB  #####          100%
libgomp-9.3.0          311 KB   #####          100%
ld_impl_linux-64-2.3  586 KB   #####          100%
__openmp_mutex-4.5     22 KB    #####          100%
Preparing transaction: ...working... done
Verifying transaction: ...working... done
Executing transaction: ...working... done

cffi-1.15.0           224 KB   #####          100%
cryptography-36.0.0   1.5 MB   #####          100%
ca-certificates-2021  121 KB   #####          100%
ruamel_yaml-0.15.100  267 KB   #####          100%
zlib-1.2.11             125 KB   #####          100%
conda-4.11.0           16.9 MB  #####          100%
readline-7.0            392 KB   #####          100%
brotlipy-0.7.0          350 KB   #####          100%
yaml-0.2.5              87 KB    #####          100%
pycparser-2.21           94 KB    #####          100%
ncurses-6.3              1.0 MB   #####          100%
pycosat-0.6.3            108 KB   #####          100%
libedit-3.1.20210910   191 KB   #####          100%
urllib3-1.26.7            104 KB   #####          100%
pyopenssl-21.0.0          48 KB    #####          100%
setuptools-58.0.4         979 KB   #####          100%
pip-21.2.2              2.0 MB   #####          100%
tk-8.6.11                3.2 MB   #####          100%
idna-3.3                  55 KB    #####          100%
certifi-2021.10.8         154 KB   #####          100%
conda-package-handli     962 KB   #####          100%
pysocks-1.7.1              27 KB    #####          100%
six-1.16.0                 18 KB    #####          100%
requests-2.26.0             59 KB    #####          100%
__libgcc_mutex-0.1          3 KB    #####          100%
tqdm-4.62.3                 79 KB    #####          100%
xz-5.2.5                   438 KB   #####          100%
sqlite-3.33.0               2.0 MB   #####          100%
wheel-0.37.0                 31 KB    #####          100%
charset-normalizer-2        33 KB    #####          100%
python-3.7.0                  31.7 MB  #####          100%
openssl-1.0.2u                3.1 MB   #####          100%
libgcc-ng-9.1.0                8.1 MB   #####          100%
```

The environment is inconsistent, please check the package plan carefully
The following packages are causing the inconsistency:

```
- defaults/linux-64::asn1crypto==0.24.0=py36_0
- defaults/linux-64::chardet==3.0.4=py36h0f667ec_1
bash: line 3: !conda: command not found
bash: line 4: !python: command not found
```

In [6]:

```
import sys
sys.path
!ls /usr/local/lib/python3.7/dist-packages
_= (sys.path.append("/usr/local/lib/python3.7/site-packages"))
!conda create -n openmmlab python=3.7 -y
```

```
!conda activate openmmlab
!conda install pytorch torchvision -c pytorch -y
!pip install openmim
!mim install mmdet
```

```
absl
absl_py-0.12.0.dist-info
alabaster
alabaster-0.7.12.dist-info
albumentations
albumentations-0.1.12.dist-info
altair
altair-4.1.0.dist-info
apiclient
appdirs-1.4.4.dist-info
appdirs.py
apt
apt_inst.cpython-37m-x86_64-linux-gnu.so
apt_inst.pyi
apt_pkg.cpython-37m-x86_64-linux-gnu.so
apt_pkg.pyi
aptsources
argcomplete
argcomplete-1.12.3.dist-info
argon2
argon2_cffi-21.1.0.dist-info
arviz
arviz-0.11.4.dist-info
astor
astor-0.8.1.dist-info
astropy
astropy-4.3.1.dist-info
astunparse
astunparse-1.6.3.dist-info
atari_py
atari_py-0.2.9.dist-info
atari_py.libs
atomicwrites
atomicwrites-1.4.0.dist-info
attr
attrs-21.2.0.dist-info
audioread
audioread-2.1.9.dist-info
autograd
autograd-1.3.dist-info
babel
Babel-2.9.1.dist-info
backcall
backcall-0.2.0.dist-info
beautifulsoup4-4.6.3.dist-info
bin
bleach
bleach-4.1.0.dist-info
blis
blis-0.4.1.dist-info
bokeh
bokeh-2.3.3.dist-info
bottleneck
Bottleneck-1.3.2.dist-info
branca
branca-0.4.2.dist-info
bs4
bs4-0.0.1.dist-info
bson
```

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cachecontrol
CacheControl-0.12.10.dist-info
cached_property-1.5.2.dist-info
cached_property.py
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cachetools-4.2.4.dist-info
caffe2
catalogue-1.0.0.dist-info
catalogue.py
certifi
certifi-2021.10.8.dist-info
cffi
cffi-1.15.0.dist-info
_cffi_backend.cpython-37m-x86_64-linux-gnu.so
cffi.libs
cftime
cftime-1.5.1.1.dist-info
CHANGELOG.md
chardet
chardet-3.0.4.dist-info
charset_normalizer
charset_normalizer-2.0.8.dist-info
chess
clang
click
click-7.1.2.dist-info
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cmake
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cmdstanpy
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colab
colorcet
colorcet-2.0.6.dist-info
colorlover
colorlover-0.3.0.dist-info
community
community-1.0.0b1.dist-info
contextlib2-0.5.5.dist-info
contextlib2.py
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coverage
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coveralls
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crcmod
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cufflinks
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cupy_backends
cupy_cuda111-9.4.0.dist-info
cupyx
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_cvxcore.cpython-37m-x86_64-linux-gnu.so
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cycler-0.11.0.dist-info
cycler.py
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decorator-4.4.2.dist-info
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docutils
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fastprogress
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Flask-1.1.4.dist-info
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google_auth-1.35.0-py3.9-nspkg.pth
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google_cloud_bigquery_storage-1.1.0-py3.8-nspkg.pth
google_cloud_core-1.0.3.dist-info
google_cloud_core-1.0.3-py3.6-nspkg.pth
google_cloud_datastore-1.8.0.dist-info
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libpasteurize
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lmdb
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nbformat
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OpenGL
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osqp
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osqppurepy
osr.py
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pandas_datareader-0.9.0.dist-info
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pasta
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plac_core.py  
plac_ext.py  
plac.py  
plac_tk.py  
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_plotly_utils  
plotlywidget  
plotnine  
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protobuf-3.17.3.dist-info  
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pyasn1  
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PySocks-1.7.1.dist-info
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python_louvain-0.15.dist-info
python_slugify-5.0.2.dist-info
python_utils
python_utils-2.5.6.dist-info
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pytz-2018.9.dist-info
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PyWavelets-1.2.0.dist-info
pywt
pyximport
PyYAML-3.13.dist-info
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QtPy-1.11.2.dist-info  
README.md  
regex  
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requests-2.23.0.dist-info  
requests_oauthlib  
requests_oauthlib-1.3.0.dist-info  
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rsa  
rsa-4.8.dist-info  
samples  
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scikit_learn-1.0.1.dist-info  
scikit_learn.libs  
scipy  
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_scs_python.cpython-37m-x86_64-linux-gnu.so  
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send2trash  
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setuptools-57.4.0.dist-info  
setuptools_git  
setuptools_git-1.2.dist-info  
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six.py  
skimage  
sklearn  
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sklearn_pandas  
sklearn_pandas-1.8.0.dist-info  
slugify  
smart_open  
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sphinxcontrib
sphinxcontrib_serializinghtml-1.1.5.dist-info
sphinxcontrib_serializinghtml-1.1.5-py3.9-nspkg.pth
sphinxcontrib_websupport-1.2.4.dist-info
sphinxcontrib_websupport-1.2.4-py3.8-nspkg.pth
sql
sqlalchemy
SQLAlchemy-1.4.27.dist-info
sqlparse
sqlparse-0.4.2.dist-info
srsly
srsly-1.0.5.dist-info
statsmodels
statsmodels-0.10.2.dist-info
sympy
sympy-1.7.1.dist-info
tables
tables-3.4.4.dist-info
tabulate-0.8.9.dist-info
tabulate.py
tblib
tblib-1.7.0.dist-info
tensorboard
tensorboard-2.7.0.dist-info
tensorboard_data_server
tensorboard_data_server-0.6.1.dist-info
tensorboard_plugin_wit
tensorboard_plugin_wit-1.8.0.dist-info
tensorflow
tensorflow-2.7.0.dist-info
tensorflow_datasets
tensorflow_datasets-4.0.1.dist-info
tensorflow_estimator
tensorflow_estimator-2.7.0.dist-info
tensorflow_gcs_config
tensorflow_gcs_config-2.7.0.dist-info
tensorflow_hub
tensorflow_hub-0.12.0.dist-info
tensorflow_io_gcs_filesystem
tensorflow_io_gcs_filesystem-0.22.0.dist-info
tensorflow_metadata
tensorflow_metadata-1.4.0.dist-info
tensorflow_probability
tensorflow_probability-0.15.0.dist-info
termcolor-1.1.0.dist-info
termcolor.py
terminado
terminado-0.12.1.dist-info
testpath
testpath-0.5.0.dist-info
tests
textblob
textblob-0.15.3.dist-info
text_unidecode
text_unidecode-1.3.dist-info
```

```
theano
Theano_PyMC-1.1.2.dist-info
thinc
thinc-7.4.0.dist-info
threadpoolctl-3.0.0.dist-info
threadpoolctl.py
tifffile
tifffile-2021.11.2.dist-info
tlz
toml
toml-0.10.2.dist-info
tomli
tomli-1.2.2.dist-info
toolz
toolz-0.11.2.dist-info
torch
torch-1.10.0+cu111.dist-info
torchaudio
torchaudio-0.10.0+cu111.dist-info
torchsummary
torchsummary-1.5.1.dist-info
torchtext
torchtext-0.11.0.dist-info
torchvision
torchvision-0.11.1+cu111.dist-info
torchvision.libs
tornado
tornado-5.1.1.dist-info
tqdm
tqdm-4.62.3.dist-info
traitlets
traitlets-5.1.1.dist-info
tree
tweepy
tweepy-3.10.0.dist-info
typeguard
typeguard-2.7.1.dist-info
typing_extensions-3.10.0.2.dist-info
typing_extensions.py
tzlocal
tzlocal-1.5.1.dist-info
uritemplate
uritemplate-3.0.1.dist-info
urllib3
urllib3-1.24.3.dist-info
vega_datasets
vega_datasets-0.9.0.dist-info
vis
wasabi
wasabi-0.8.2.dist-info
wcwidth
wcwidth-0.2.5.dist-info
webencodings
webencodings-0.5.1.dist-info
werkzeug
Werkzeug-1.0.1.dist-info
wheel
wheel-0.37.0.dist-info
widgetsnbextension
widgetsnbextension-3.5.2.dist-info
wordcloud
wordcloud-1.5.0.dist-info
wrapt
wrapt-1.13.3.dist-info
xarray
```

```

xarray-0.18.2.dist-info
xgboost
xgboost-0.90.dist-info
xlrd
xlrd-1.1.0.dist-info
xlwt
xlwt-1.3.0.dist-info
yaml
yellowbrick
yellowbrick-1.3.post1.dist-info
zict
zict-2.0.0.dist-info
zipp-3.6.0.dist-info
zipp.py
zmq
Collecting package metadata (current_repodata.json): - \ | done
Solving environment: - done

```

Package Plan

environment location: /usr/local/envs/openmmlab

added / updated specs:
- python=3.7

The following packages will be downloaded:

package	build	
_libgcc_mutex-0.1	main	3 KB
ca-certificates-2021.10.26	h06a4308_2	115 KB
certifi-2021.10.8	py37h06a4308_0	151 KB
ncurses-6.3	h7f8727e_2	782 KB
pip-21.2.2	py37h06a4308_0	1.8 MB
setuptools-58.0.4	py37h06a4308_0	775 KB
tk-8.6.11	h1ccaba5_0	3.0 MB
wheel-0.37.0	pyhd3eb1b0_1	33 KB
xz-5.2.5	h7b6447c_0	341 KB
zlib-1.2.11	h7f8727e_4	108 KB
<hr/>		
Total:		7.1 MB

The following NEW packages will be INSTALLED:

_libgcc_mutex	pkgs/main/linux-64::__libgcc_mutex-0.1-main
_openmp_mutex	pkgs/main/linux-64::__openmp_mutex-4.5-1_gnu
ca-certificates	pkgs/main/linux-64::ca-certificates-2021.10.26-h06a4308_2
certifi	pkgs/main/linux-64::certifi-2021.10.8-py37h06a4308_0
ld_impl_linux-64	pkgs/main/linux-64::ld_impl_linux-64-2.35.1-h7274673_9
libffi	pkgs/main/linux-64::libffi-3.3-he6710b0_2
libgcc-ng	pkgs/main/linux-64::libgcc-ng-9.3.0-h5101ec6_17
libgomp	pkgs/main/linux-64::libgomp-9.3.0-h5101ec6_17
libstdcxx-ng	pkgs/main/linux-64::libstdcxx-ng-9.3.0-hd4cf53a_17
ncurses	pkgs/main/linux-64::ncurses-6.3-h7f8727e_2
openssl	pkgs/main/linux-64::openssl-1.1.11-h7f8727e_0
pip	pkgs/main/linux-64::pip-21.2.2-py37h06a4308_0
python	pkgs/main/linux-64::python-3.7.11-h12debd9_0
readline	pkgs/main/linux-64::readline-8.1-h27cf23_0
setuptools	pkgs/main/linux-64::setuptools-58.0.4-py37h06a4308_0
sqlite	pkgs/main/linux-64::sqlite-3.36.0-hc218d9a_0
tk	pkgs/main/linux-64::tk-8.6.11-h1ccaba5_0
wheel	pkgs/main/noarch::wheel-0.37.0-pyhd3eb1b0_1
xz	pkgs/main/linux-64::xz-5.2.5-h7b6447c_0
zlib	pkgs/main/linux-64::zlib-1.2.11-h7f8727e_4

```

Downloading and Extracting Packages
libgcc_mutex-0.1      | 3 KB      | : 100% 1.0/1 [00:00<00:00, 12.33it/s]
ca-certificates-2021  | 115 KB     | : 100% 1.0/1 [00:00<00:00, 14.47it/s]
zlib-1.2.11            | 108 KB     | : 100% 1.0/1 [00:00<00:00, 15.60it/s]
tk-8.6.11              | 3.0 MB     | : 100% 1.0/1 [00:00<00:00, 6.06it/s]
xz-5.2.5               | 341 KB     | : 100% 1.0/1 [00:00<00:00, 15.52it/s]
pip-21.2.2              | 1.8 MB     | : 100% 1.0/1 [00:00<00:00, 6.22it/s]
ncurses-6.3             | 782 KB     | : 100% 1.0/1 [00:00<00:00, 3.65it/s]
setuptools-58.0.4       | 775 KB     | : 100% 1.0/1 [00:00<00:00, 10.88it/s]
certifi-2021.10.8      | 151 KB     | : 100% 1.0/1 [00:00<00:00, 19.28it/s]
wheel-0.37.0             | 33 KB      | : 100% 1.0/1 [00:00<00:00, 19.70it/s]
Preparing transaction: | / - done
Verifying transaction: | / - \ | / - \ done
Executing transaction: / - \ | / - \ | done
#
# To activate this environment, use
#
#   $ conda activate openmmlab
#
# To deactivate an active environment, use
#
#   $ conda deactivate

```

CommandNotFoundError: Your shell has not been properly configured to use 'conda activate'.
To initialize your shell, run

```
$ conda init <SHELL_NAME>
```

Currently supported shells are:

- bash
- fish
- tcsh
- xonsh
- zsh
- powershell

See 'conda init --help' for more information and options.

IMPORTANT: You may need to close and restart your shell after running 'conda init'.

Collecting package metadata (current_repodata.json): - \ | / - \ | / - \ | / - \ | / - \ | / - done

Solving environment: | / - \ | / - \ | / - \ | / -

The environment is inconsistent, please check the package plan carefully
The following packages are causing the inconsistency:

```

- defaults/linux-64::asn1crypto==0.24.0=py36_0
- defaults/linux-64::chardet==3.0.4=py36h0f667ec_1
\ | / - \ | done

```

```
## Package Plan ##
```

```
environment location: /usr/local
```

```
added / updated specs:
- pytorch
- torchvision
```

The following packages will be downloaded:

package	build		
asn1crypto-1.4.0	py_0	80 KB	
blas-1.0	mk1	6 KB	
bzip2-1.0.8	h7b6447c_0	78 KB	
chardet-4.0.0	py37h06a4308_1003	195 KB	
cudatoolkit-11.3.1	h2bc3f7f_2	549.3 MB	
ffmpeg-4.3	hf484d3e_0	9.9 MB	pytorch
freetype-2.11.0	h70c0345_0	618 KB	
giflib-5.2.1	h7b6447c_0	78 KB	
gmp-6.2.1	h2531618_2	539 KB	
gnutls-3.6.15	he1e5248_0	1.0 MB	
intel-openmp-2021.4.0	h06a4308_3561	4.2 MB	
jpeg-9d	h7f8727e_0	232 KB	
lame-3.100	h7b6447c_0	323 KB	
lcms2-2.12	h3be6417_0	312 KB	
libiconv-1.15	h63c8f33_5	721 KB	
libidn2-2.3.2	h7f8727e_0	81 KB	
libpng-1.6.37	hbc83047_0	278 KB	
libtasn1-4.16.0	h27cf23_0	58 KB	
libtiff-4.2.0	h85742a9_0	502 KB	
libunistring-0.9.10	h27cf23_0	536 KB	
libuv-1.40.0	h7b6447c_0	736 KB	
libwebp-1.2.0	h89dd481_0	493 KB	
libwebp-base-1.2.0	h27cf23_0	437 KB	
lz4-c-1.9.3	h295c915_1	185 KB	
mkl-2021.4.0	h06a4308_640	142.6 MB	
mkl-service-2.4.0	py37h7f8727e_0	56 KB	
mkl_fft-1.3.1	py37hd3c417c_0	172 KB	
mkl_random-1.2.2	py37h51133e4_0	287 KB	
nettle-3.7.3	hbbd107a_1	809 KB	
numpy-1.21.2	py37h20f2e39_0	23 KB	
numpy-base-1.21.2	py37h79a1101_0	4.8 MB	
olefile-0.46	py37_0	50 KB	
openh264-2.1.1	h4ff587b_0	711 KB	
pillow-8.4.0	py37h5aabda8_0	644 KB	
pytorch-1.10.1	py3.7_cuda11.3_cudnn8.2.0_0	1.21 GB	pyto
rch			
pytorch-mutex-1.0	cuda	3 KB	pytorch
torchvision-0.11.2	py37_cu113	30.4 MB	pytorch
typing_extensions-3.10.0.2	pyh06a4308_0	31 KB	
zstd-1.4.9	haebb681_0	480 KB	
	Total:	1.94 GB	

The following NEW packages will be INSTALLED:

blas	pkgs/main/linux-64::blas-1.0-mkl
bzip2	pkgs/main/linux-64::bzip2-1.0.8-h7b6447c_0
cudatoolkit	pkgs/main/linux-64::cudatoolkit-11.3.1-h2bc3f7f_2
ffmpeg	pytorch/linux-64::ffmpeg-4.3-hf484d3e_0
freetype	pkgs/main/linux-64::freetype-2.11.0-h70c0345_0
giflib	pkgs/main/linux-64::giflib-5.2.1-h7b6447c_0
gmp	pkgs/main/linux-64::gmp-6.2.1-h2531618_2
gnutls	pkgs/main/linux-64::gnutls-3.6.15-he1e5248_0
intel-openmp	pkgs/main/linux-64::intel-openmp-2021.4.0-h06a4308_3561
jpeg	pkgs/main/linux-64::jpeg-9d-h7f8727e_0
lame	pkgs/main/linux-64::lame-3.100-h7b6447c_0
lcms2	pkgs/main/linux-64::lcms2-2.12-h3be6417_0
libiconv	pkgs/main/linux-64::libiconv-1.15-h63c8f33_5
libidn2	pkgs/main/linux-64::libidn2-2.3.2-h7f8727e_0
libpng	pkgs/main/linux-64::libpng-1.6.37-hbc83047_0

```

libtasn1          pkgs/main/linux-64::libtasn1-4.16.0-h27cf23_0
libtiff           pkgs/main/linux-64::libtiff-4.2.0-h85742a9_0
libunistring     pkgs/main/linux-64::libunistring-0.9.10-h27cf23_0
libuv             pkgs/main/linux-64::libuv-1.40.0-h7b6447c_0
libwebp           pkgs/main/linux-64::libwebp-1.2.0-h89dd481_0
libwebp-base      pkgs/main/linux-64::libwebp-base-1.2.0-h27cf23_0
lz4-c             pkgs/main/linux-64::lz4-c-1.9.3-h295c915_1
mkl               pkgs/main/linux-64::mkl-2021.4.0-h06a4308_640
mkl-service       pkgs/main/linux-64::mkl-service-2.4.0-py37h7f8727e_0
mkl_fft           pkgs/main/linux-64::mkl_fft-1.3.1-py37hd3c417c_0
mkl_random        pkgs/main/linux-64::mkl_random-1.2.2-py37h51133e4_0
nettle            pkgs/main/linux-64::nettle-3.7.3-hbbd107a_1
numpy             pkgs/main/linux-64::numpy-1.21.2-py37h20f2e39_0
numpy-base        pkgs/main/linux-64::numpy-base-1.21.2-py37h79a1101_0
olefile           pkgs/main/linux-64::olefile-0.46-py37_0
openh264          pkgs/main/linux-64::openh264-2.1.1-h4ff587b_0
pillow            pkgs/main/linux-64::pillow-8.4.0-py37h5aabda8_0
pytorch           pytorch/linux-64::pytorch-1.10.1-py3.7_cuda11.3_cudnn8.2.0_
0
pytorch-mutex    pytorch/noarch::pytorch-mutex-1.0-cuda
torchvision       pytorch/linux-64::torchvision-0.11.2-py37_cu113
typing_extensions pkgs/main/noarch::typing_extensions-3.10.0.2-pyh06a4308_0
zstd              pkgs/main/linux-64::zstd-1.4.9-haebb681_0

```

The following packages will be UPDATED:

asn1crypto	pkgs/main/linux-64::asn1crypto-0.24.0~ --> pkgs/main/noarch::asn1crypto-1.4.0-py_0
chardet	3.0.4-py36h0f667ec_1 --> 4.0.0-py37h06a4308_1003

Downloading and Extracting Packages

lcms2-2.12	312 KB	:	100%	1.0/1	[00:00<00:00, 9.01it/s]
openh264-2.1.1	711 KB	:	100%	1.0/1	[00:00<00:00, 16.28it/s]
libidn2-2.3.2	81 KB	:	100%	1.0/1	[00:00<00:00, 26.34it/s]
asn1crypto-1.4.0	80 KB	:	100%	1.0/1	[00:00<00:00, 25.07it/s]
cudatoolkit-11.3.1	549.3 MB	:	100%	1.0/1	[00:17<00:00, 17.60s/it]
lz4-c-1.9.3	185 KB	:	100%	1.0/1	[00:00<00:00, 7.49it/s]
typing_extensions-3.	31 KB	:	100%	1.0/1	[00:00<00:00, 9.64it/s]
libwebp-1.2.0	493 KB	:	100%	1.0/1	[00:00<00:00, 9.63it/s]
pytorch-mutex-1.0	3 KB	:	100%	1.0/1	[00:01<00:00, 1.36s/it]
mkl_fft-1.3.1	172 KB	:	100%	1.0/1	[00:00<00:00, 6.22it/s]
blas-1.0	6 KB	:	100%	1.0/1	[00:00<00:00, 21.24it/s]
gnutls-3.6.15	1.0 MB	:	100%	1.0/1	[00:00<00:00, 13.88it/s]
gmp-6.2.1	539 KB	:	100%	1.0/1	[00:00<00:00, 17.23it/s]
numpy-base-1.21.2	4.8 MB	:	100%	1.0/1	[00:00<00:00, 3.99it/s]
bzip2-1.0.8	78 KB	:	100%	1.0/1	[00:00<00:00, 23.66it/s]
libtasn1-4.16.0	58 KB	:	100%	1.0/1	[00:00<00:00, 23.30it/s]
intel-openmp-2021.4.	4.2 MB	:	100%	1.0/1	[00:00<00:00, 6.62it/s]
jpeg-9d	232 KB	:	100%	1.0/1	[00:00<00:00, 17.95it/s]
libuv-1.40.0	736 KB	:	100%	1.0/1	[00:00<00:00, 17.84it/s]
lame-3.100	323 KB	:	100%	1.0/1	[00:00<00:00, 20.47it/s]
mkl-service-2.4.0	56 KB	:	100%	1.0/1	[00:00<00:00, 22.49it/s]
nettle-3.7.3	809 KB	:	100%	1.0/1	[00:00<00:00, 15.77it/s]
freetype-2.11.0	618 KB	:	100%	1.0/1	[00:00<00:00, 15.27it/s]
libtiff-4.2.0	502 KB	:	100%	1.0/1	[00:00<00:00, 16.48it/s]
giflib-5.2.1	78 KB	:	100%	1.0/1	[00:00<00:00, 22.91it/s]
libwebp-base-1.2.0	437 KB	:	100%	1.0/1	[00:00<00:00, 19.73it/s]
ffmpeg-4.3	9.9 MB	:	100%	1.0/1	[00:02<00:00, 2.31s/it]
numpy-1.21.2	23 KB	:	100%	1.0/1	[00:00<00:00, 19.74it/s]
zstd-1.4.9	480 KB	:	100%	1.0/1	[00:00<00:00, 17.33it/s]
torchvision-0.11.2	30.4 MB	:	100%	1.0/1	[00:04<00:00, 4.82s/it]
libiconv-1.15	721 KB	:	100%	1.0/1	[00:00<00:00, 14.59it/s]

```
mkl-2021.4.0           | 142.6 MB   | : 100% 1.0/1 [00:04<00:00, 4.13s/it]
mkl_random-1.2.2       | 287 KB     | : 100% 1.0/1 [00:00<00:00, 15.62it/s]
pytorch-1.10.1          | 1.21 GB    | : 100% 1.0/1 [02:59<00:00, 179.92s/it]
pillow-8.4.0            | 644 KB     | : 100% 1.0/1 [00:00<00:00, 12.18it/s]
olefile-0.46             | 50 KB      | : 100% 1.0/1 [00:00<00:00, 15.63it/s]
libpng-1.6.37            | 278 KB     | : 100% 1.0/1 [00:00<00:00, 17.87it/s]
libunistring-0.9.10     | 536 KB     | : 100% 1.0/1 [00:00<00:00, 17.67it/s]
chardet-4.0.0             | 195 KB     | : 100% 1.0/1 [00:00<00:00, 18.71it/s]
Preparing transaction: - \ | done
Verifying transaction: - \ | / - \ | / - \ | / - done
Executing transaction: | / - \ | / - \ | / - \ | / - \ | / - \ | / - \ | / - \ | / - \ |
/ - \ | / By downloading and using the CUDA Toolkit conda packages, you accept the terms and conditions of the CUDA End User License Agreement (EULA): https://docs.nvidia.com/cuda/eula/index.html

- \ | / - \ done
Collecting openmim
  Downloading openmim-0.1.5.tar.gz (35 kB)
Collecting Click==7.1.2
  Downloading click-7.1.2-py2.py3-none-any.whl (82 kB)
|██████████| 82 kB 1.4 MB/s
Collecting colorama
  Downloading colorama-0.4.4-py2.py3-none-any.whl (16 kB)
Requirement already satisfied: requests in /usr/local/lib/python3.7/site-packages (from openmim) (2.26.0)
Collecting model-index
  Downloading model_index-0.1.11-py3-none-any.whl (34 kB)
Collecting pandas
  Downloading pandas-1.3.5-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (11.3 MB)
|██████████| 11.3 MB 60.1 MB/s
Collecting tabulate
  Downloading tabulate-0.8.9-py3-none-any.whl (25 kB)
Collecting markdown
  Downloading Markdown-3.3.6-py3-none-any.whl (97 kB)
|██████████| 97 kB 9.7 MB/s
Collecting ordered-set
  Downloading ordered-set-4.0.2.tar.gz (10 kB)
Collecting pyyaml
  Downloading PyYAML-6.0-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_12_x86_64.manylinux2010_x86_64.whl (596 kB)
|██████████| 596 kB 77.6 MB/s
Collecting importlib-metadata>=4.4
  Downloading importlib_metadata-4.10.0-py3-none-any.whl (17 kB)
Requirement already satisfied: typing-extensions>=3.6.4 in /usr/local/lib/python3.7/site-packages (from importlib-metadata>=4.4->markdown->model-index->openmim) (3.10.0.2)
Collecting zipp>=0.5
  Downloading zipp-3.6.0-py3-none-any.whl (5.3 kB)
Requirement already satisfied: numpy>=1.17.3 in /usr/local/lib/python3.7/site-packages (from pandas->openmim) (1.21.2)
Collecting pytz>=2017.3
  Downloading pytz-2021.3-py2.py3-none-any.whl (503 kB)
|██████████| 503 kB 99.1 MB/s
Collecting python-dateutil>=2.7.3
  Downloading python_dateutil-2.8.2-py2.py3-none-any.whl (247 kB)
|██████████| 247 kB 113.2 MB/s
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from python-dateutil>=2.7.3->pandas->openmim) (1.16.0)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.7/site-packages (from requests->openmim) (2.0.4)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/site-packages (from requests->openmim) (2021.10.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.7/site-packages (from requests->openmim) (1.26.7)
```

```

Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/site-packages (from requests->openmim) (3.3)
Building wheels for collected packages: openmim, ordered-set
  Building wheel for openmim (setup.py) ... done
    Created wheel for openmim: filename=openmim-0.1.5-py2.py3-none-any.whl size=42502 sha256=e9ca9f20707df73aad5adce8dfbf17287e6210bc0042f22bb38b34066949e352
    Stored in directory: /root/.cache/pip/wheels/16/8b/e1/bdebbbc687aa50224a5ce46fe97a040a0c59f92b34bfc750b6
  Building wheel for ordered-set (setup.py) ... done
    Created wheel for ordered-set: filename=ordered_set-4.0.2-py2.py3-none-any.whl size=8219 sha256=ff3b81b47abab28c715062ec81261d64a364b93c3d60647bb161cb20912602cc
    Stored in directory: /root/.cache/pip/wheels/73/2b/f6/26e9f84153c25050fe7c09e88f8e32a6be3c7034a38c418319
Successfully built openmim ordered-set
Installing collected packages: zipp, importlib-metadata, pyyaml, pytz, python-dateutil, ordered-set, markdown, Click, tabulate, pandas, model-index, colorama, openmim
Successfully installed Click-7.1.2 colorama-0.4.4 importlib-metadata-4.10.0 mark-down-3.3.6 model-index-0.1.11 openmim-0.1.5 ordered-set-4.0.2 pandas-1.3.5 python-dateutil-2.8.2 pytz-2021.3 pyyaml-6.0 tabulate-0.8.9 zipp-3.6.0
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv
```

```

installing mmdet from https://github.com/open-mmlab/mmdetection.git.
Cloning into '/tmp/tmpkng_jser/mmdetection'...
remote: Enumerating objects: 22429, done.
remote: Counting objects: 100% (2/2), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 22429 (delta 0), reused 1 (delta 0), pack-reused 22427
Receiving objects: 100% (22429/22429), 25.48 MiB | 31.28 MiB/s, done.
Resolving deltas: 100% (15705/15705), done.
Note: checking out '5e246d5e3bc3310b5c625fb57bc03d2338ca39bc'.
```

You are in 'detached HEAD' state. You can look around, make experimental changes and commit them, and you can discard any commits you make in this state without impacting any branches by performing another checkout.

If you want to create a new branch to retain commits you create, you may do so (now or later) by using -b with the checkout command again. Example:

```
git checkout -b <new-branch-name>
```

```

installing dependency: mmcv-full
installing mmcv-full from wheel.
Looking in links: https://download.openmmlab.com/mmcv/dist/cu113/torch1.10.0/index.html
Collecting mmcv-full==1.4.1
  Downloading https://download.openmmlab.com/mmcv/dist/cu113/torch1.10.0/mmcv_full-1.4.1-cp37-cp37m-manylinux1_x86_64.whl (58.4 MB)
    ██████████| 58.4 MB 33.5 MB/s
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/site-packages (from mmcv-full==1.4.1) (8.4.0)
Collecting addict
  Downloading addict-2.4.0-py3-none-any.whl (3.8 kB)
Collecting yapf
  Downloading yapf-0.31.0-py2.py3-none-any.whl (185 kB)
    ██████████| 185 kB 7.3 MB/s
Collecting opencv-python>=3
  Downloading opencv_python-4.5.4.60-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (60.3 MB)
    ██████████| 60.3 MB 1.2 MB/s
Requirement already satisfied: pyyaml in /usr/local/lib/python3.7/site-packages (from mmcv-full==1.4.1) (6.0)
```

```
Requirement already satisfied: numpy in /usr/local/lib/python3.7/site-packages
  (from mmcv-full==1.4.1) (1.21.2)
Collecting packaging
  Downloading packaging-21.3-py3-none-any.whl (40 kB)
    ██████████| 40 kB 7.0 MB/s
Collecting pyparsing!=3.0.5,>=2.0.2
  Downloading pyparsing-3.0.6-py3-none-any.whl (97 kB)
    ██████████| 97 kB 8.4 MB/s
Installing collected packages: pyparsing, yapf, packaging, opencv-python, addict, mmcv-full
Successfully installed addict-2.4.0 mmcv-full-1.4.1 opencv-python-4.5.4.60 packaging-21.3 pyparsing-3.0.6 yapf-0.31.0
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv
Successfully installed mmcv-full.
Successfully installed dependencies.
Collecting cython
  Downloading Cython-0.29.26-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.manylinux_2_24_x86_64.whl (1.9 MB)
    ██████████| 1.9 MB 7.5 MB/s
Requirement already satisfied: numpy in /usr/local/lib/python3.7/site-packages
  (from -r /tmp/tmpkng_jsr/mmdetection/requirements/build.txt (line 3)) (1.21.2)
Installing collected packages: cython
Successfully installed cython-0.29.26
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv
Processing /tmp/tmpkng_jsr/mmdetection
Collecting matplotlib
  Downloading matplotlib-3.5.1-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.whl (11.2 MB)
    ██████████| 11.2 MB 8.0 MB/s
Requirement already satisfied: numpy in /usr/local/lib/python3.7/site-packages
  (from mmdet==2.19.1) (1.21.2)
Requirement already satisfied: six in /usr/local/lib/python3.7/site-packages (from mmdet==2.19.1) (1.16.0)
Collecting terminaltables
  Downloading terminaltables-3.1.10-py2.py3-none-any.whl (15 kB)
Collecting pycocotools
  Downloading pycocotools-2.0.3.tar.gz (106 kB)
    ██████████| 106 kB 81.1 MB/s
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/site-packages (from matplotlib->mmdet==2.19.1) (21.3)
Collecting cycler>=0.10
  Downloading cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting fonttools>=4.22.0
  Downloading fonttools-4.28.5-py3-none-any.whl (890 kB)
    ██████████| 890 kB 71.7 MB/s
Requirement already satisfied: pyparsing>=2.2.1 in /usr/local/lib/python3.7/site-packages (from matplotlib->mmdet==2.19.1) (3.0.6)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.7/site-packages (from matplotlib->mmdet==2.19.1) (2.8.2)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.7/site-packages (from matplotlib->mmdet==2.19.1) (8.4.0)
Collecting kiwisolver>=1.0.1
  Downloading kiwisolver-1.3.2-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.whl (1.1 MB)
    ██████████| 1.1 MB 65.2 MB/s
Requirement already satisfied: setuptools>=18.0 in /usr/local/lib/python3.7/site-packages (from pycocotools->mmdet==2.19.1) (58.0.4)
Requirement already satisfied: cython>=0.27.3 in /usr/local/lib/python3.7/site-packages (from pycocotools->mmdet==2.19.1) (0.29.26)
Building wheels for collected packages: mmdet, pycocotools
  Building wheel for mmdet (setup.py) ... done
```

```
Created wheel for mmdet: filename=mmdet-2.19.1-py3-none-any.whl size=1244321 s
ha256=0092d5410fe837483b40f4cb7e37b0e9497468147a200d2bd2404f4d3e8a76c2
Stored in directory: /tmp/pip-ephem-wheel-cache-04zf56_k/wheels/63/9d/e2/d05b3
97b67edf61877a332d3af7cf931a3414e613baa100fea
Building wheel for pycocotools (setup.py) ... done
Created wheel for pycocotools: filename=pycocotools-2.0.3-cp37-cp37m-linux_x86
_64.whl size=273730 sha256=7b5c92ed8fff580688d63e981a309a37445dd46788f7dafe6693e
96a731960cc
Stored in directory: /root/.cache/pip/wheels/a2/09/4f/27f24df9927973a2dd820c3f
b741c49d1208b25eb5331181c5
Successfully built mmdet pycocotools
Installing collected packages: kiwisolver, fonttools, cycler, matplotlib, termin
altables, pycocotools, mmdet
Successfully installed cycler-0.11.0 fonttools-4.28.5 kiwisolver-1.3.2 matplotlib
b-3.5.1 mmdet-2.19.1 pycocotools-2.0.3 terminaltables-3.1.10
WARNING: Running pip as the 'root' user can result in broken permissions and con
flicting behaviour with the system package manager. It is recommended to use a v
irtual environment instead: https://pip.pypa.io/warnings/venv
Successfully installed mmdet.
```

In [7]:

```
!git clone https://github.com/open-mmlab/mmdetection.git
!mkdir mmdetection/checkpoints
!wget -c https://download.openmmlab.com/mmdetection/v2.0/mask_rcnn/mask_rcnn_r50
      -O mmdetection/checkpoints/mask_rcnn_r50_caffe_fpn_mstrain-poly_3x_coco_bb
```

```
Cloning into 'mmdetection'...
remote: Enumerating objects: 22429, done.
remote: Counting objects: 100% (2/2), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 22429 (delta 0), reused 1 (delta 0), pack-reused 22427
Receiving objects: 100% (22429/22429), 25.48 MiB | 11.57 MiB/s, done.
Resolving deltas: 100% (15695/15695), done.
--2021-12-23 01:40:54-- https://download.openmmlab.com/mmdetection/v2.0/mask_rc
nn/mask_rcnn_r50_caffe_fpn_mstrain-poly_3x_coco/mask_rcnn_r50_caffe_fpn_mstrain-
poly_3x_coco_bbox_mAP-0.408_segm_mAP-0.37_20200504_163245-42aa3d00.pth
Resolving download.openmmlab.com (download.openmmlab.com)... 47.88.36.72
Connecting to download.openmmlab.com (download.openmmlab.com)|47.88.36.72|:44
3... connected.
HTTP request sent, awaiting response... 200 OK
Length: 177867103 (170M) [application/octet-stream]
Saving to: 'mmdetection/checkpoints/mask_rcnn_r50_caffe_fpn_mstrain-poly_3x_coco
_bbox_mAP-0.408_segm_mAP-0.37_20200504_163245-42aa3d00.pth'

mmdetection/checkpo 100%[=====>] 169.63M 9.14MB/s    in 20s

2021-12-23 01:41:15 (8.30 MB/s) - 'mmdetection/checkpoints/mask_rcnn_r50_caffe_f
pn_mstrain-poly_3x_coco_bbox_mAP-0.408_segm_mAP-0.37_20200504_163245-42aa3d00.p
th' saved [177867103/177867103]
```

In [8]:

```
from mmdet.apis import inference_detector, init_detector, show_result_pyplot
config = 'mmdetection/configs/mask_rcnn/mask_rcnn_r50_caffe_fpn_mstrain-poly_3x_
checkpoint = 'mmdetection/checkpoints/mask_rcnn_r50_caffe_fpn_mstrain-poly_3x_co
model = init_detector(config, checkpoint, device='cuda:0')
```

```
load checkpoint from local path: mmdetection/checkpoints/mask_rcnn_r50_caffe_fpn
_mstrain-poly_3x_coco_bbox_mAP-0.408_segm_mAP-0.37_20200504_163245-42aa3d00.pth
```

We also define some functions to help us display images and visualize activity progress to
sanitize cell outputs.

In [9]:

```

# Global Image Load Functions
def load_img(path):
    img = tf.io.read_file(path)
    img = tf.image.decode_jpeg(img, channels=3)
    return img

def imread(img_path):
    img = cv2.imread(img_path)
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    return img

# Global Display Function
# Image [array] -> Array of images
# Data [dict] -> Dictionary of Titles, Labels Accuracy, etc.
def display_image(images, data):
    num_of_images = len(images)

    if num_of_images > 1:
        # Multiple-Images
        frame = plt.figure(figsize=(25,10))
        for i, image in enumerate(images):
            subframe = frame.add_subplot(1, num_of_images, i+1)
            if data[i] is not None:
                if type(data[i]) is dict:
                    if data[i]['original']:
                        image_type = 'Original'
                    else:
                        image_type = 'Enhanced'
                    average_score = np.mean(data[i]['top_10_scores'])
                    plt.title(f'{image_type}\nAverage object score = {average_score}', fontweight='bold')
                else:
                    plt.title(data[i], fontsize=14)
            subframe.axis('off')
            subframe.imshow(image)
        plt.show()
    else:
        # Single Image
        frame = plt.figure(figsize=(7,5))
        if type(data[0]) is dict:
            average_score = np.mean(data[0]['top_10_scores'])
            plt.title(f'Average object score = {average_score}', fontsize=14)
        else:
            plt.title(data[0], fontsize=14)
        plt.axis('off')
        plt.imshow(images[0])
        plt.show()

def progress(value, max=100):
    return HTML("""
        <progress
            value='{value}'
            max='{max}',
            style='width: 100%'
        >
            {value}
        </progress>
    """.format(value=value, max=max))

```

GPU check

Make sure we're running this notebook on a GPU instance.

```
In [10]: devices = tf.config.list_physical_devices('GPU')
print(f'GPU available: {devices}'')
```

```
GPU available: [PhysicalDevice(name='/physical_device:GPU:0', device_type='GP
U')]
```

Upload Footage & Generate Dataset

Upload CCTV Video or Get Drive Dataset

Select from the dropdown on the right what dataset you prefer to use.

- video - Upload a Custom Video (Execution Time Varies)
- video_demo - A Short Demo Video (Quick Execution Time)
- image - 6000+ Images from the VisDrone Dataset (Long Execution Time)
- image_small - 500 Images from the VisDrone Dataset (Medium Execution Time)
- image_tiny - 50 Images from the VisDrone Dataset (Quick Execution Time)

```
In [11]: dst_path = ''
filename = ''
```

```
In [12]: def get_data(data_type='image'):
    if data_type == 'image':
        upload_folder = 'drive/MyDrive/Data/train/images'
        return (None, None)
    elif data_type == 'image_small':
        upload_folder = 'drive/MyDrive/Data/train_small/images'
        return (None, None)
    elif data_type == 'image_tiny':
        upload_folder = 'drive/MyDrive/Data/train_tiny/images'
        return (None, None)
    else:
        image_folder = None
        upload_folder = 'videos'

    if os.path.isdir(upload_folder):
        shutil.rmtree(upload_folder)
        os.mkdir(upload_folder)

    if data_type == 'video_demo':
        demo_video = 'drive/MyDrive/Data/test4.mp4'
        demo_video_destination = 'videos/test4.mp4'
        filename = 'test4.mp4'
        copyfile(demo_video, demo_video_destination)
        dst_path = os.path.join(upload_folder, filename)
        return (dst_path, filename)
    else:
        uploaded = files.upload()
        for f in uploaded.keys():
```

```

filename = f
dst_path = os.path.join(upload_folder, f)
print(f'move {f} to {dst_path}')
shutil.move(f, dst_path)
return (dst_path, f)

dataset = "image_tiny" #@param ["image", "video", "image_small", "image_tiny", "image_medium"]
upload_folder = ''
dst_path, filenames = get_data(dataset)

```

Now we extract all of the video's frames and build our ./footage directory, which will serve as our dataset for this project.

Execution time can be quite long on longer/higher-resolution videos.

Set **num_frames_to_process** to set the number of video frames to extract and run the following models on.

```
num_frames_to_process = total_frames # To process all frames (slow
with long videos)
```

```
In [13]: if (dataset == 'video') or (dataset == 'video_demo'):
    print('hey')
    video = cv2.VideoCapture(dst_path)
    total_frames = int(video.get(cv2.CAP_PROP_FRAME_COUNT))
    num_frames_to_process = 100
    out = display(progress(0, 100), display_id=True)
    success = True
    count = 1

    if os.path.isdir('original'):
        shutil.rmtree('original')
    os.mkdir('original')

    print(f'Extracting {num_frames_to_process} frames from {filename}')
    while success and count <= num_frames_to_process:
        success, frame = video.read()
        num = str(count).zfill(4)
        name = './original/' + num + '.jpg'
        if success == True:
            cv2.imwrite(name, frame)
            count = count + 1
            out.update(progress((count * 100) / num_frames_to_process, 100))
        else:
            break
    print('Frame extraction complete.')
```

Object Detection - *Pre-Enhancement*

We will first perform object detection on our dataset before upscaling/enhancement.

First, let's define the path to our dataset:

```
In [14]: if (dataset == 'video') or (dataset == 'video_demo'):
```

```

        original_path = 'original'
    elif dataset == 'image':
        original_path = 'drive/MyDrive/Data/train/images'
    elif dataset == 'image_small':
        original_path = 'drive/MyDrive/Data/train_small/images'
    else:
        original_path = 'drive/MyDrive/Data/train_tiny/images'

```

And create the appropriate directories to store our processed frames.

```
In [15]: os.mkdir('original_objects')
os.mkdir('enhanced_objects')

# Detected Objects
os.mkdir('detected')

# Masked Objects
os.mkdir('masked')
```

1. Setup inception_resnet_v2 for object detection

We use Google's `inception_resnet_v2` convolutional neural network to detect objects in our dataset of CCTV footage.

```
In [16]: module_handle = "https://tfhub.dev/google/faster_rcnn/openimages_v4/inception_re
detector = hub.load(module_handle).signatures['default']

INFO:tensorflow:Saver not created because there are no variables in the graph to
restore
INFO:tensorflow:Saver not created because there are no variables in the graph to
restore
```

2. Setup detector

We setup the object detection model as well as define some helper functions to allow us to display images with bounding boxes displaying the detected objects' names and confidence scores.

```
In [17]: def draw_bounding_box_on_image(image,
                                    ymin,
                                    xmin,
                                    ymax,
                                    xmax,
                                    color,
                                    font,
                                    thickness=1,
                                    display_str_list=()):
    """Adds a bounding box to an image."""
    draw = ImageDraw.Draw(image)
    im_width, im_height = image.size
    (left, right, top, bottom) = (xmin * im_width, xmax * im_width,
                                  ymin * im_height, ymax * im_height)
    draw.line([(left, top), (left, bottom), (right, bottom), (right, top)],
```

```

        (left, top)],
        width=thickness,
        fill=color)

# If the total height of the display strings added to the top of the bounding
# box exceeds the top of the image, stack the strings below the bounding box
# instead of above.
display_str_heights = [font.getsize(ds)[1] for ds in display_str_list]
# Each display_str has a top and bottom margin of 0.05x.
total_display_str_height = (1 + 2 * 0.05) * sum(display_str_heights)

if top > total_display_str_height:
    text_bottom = top
else:
    text_bottom = top + total_display_str_height
# Reverse list and print from bottom to top.
for display_str in display_str_list[::-1]:
    text_width, text_height = font.getsize(display_str)
    margin = np.ceil(0.05 * text_height)
    draw.rectangle([(left, text_bottom - text_height - 2 * margin),
                    (left + text_width, text_bottom)],
                  fill=color)
    draw.text((left + margin, text_bottom - text_height - margin),
              display_str,
              fill="black",
              font=font)
    text_bottom -= text_height - 2 * margin

def draw_boxes(image, boxes, class_names, scores, max_boxes=10, min_score=0.1):
    """Overlay labeled boxes on an image with formatted scores and label names."""
    colors = list(ImageColor.colormap.values())
    font_size = image.shape[0] // 23 # Set fontsize proportional to image width

    try:
        font = ImageFont.truetype("/usr/share/fonts/truetype/liberation/LiberationSa
                                    font_size)
    except IOError:
        print("Font not found, using default font.")
        font = ImageFont.load_default()

    for i in range(min(boxes.shape[0], max_boxes)):
        if scores[i] >= min_score:
            ymin, xmin, ymax, xmax = tuple(boxes[i])
            display_str = "{}: {}%".format(class_names[i].decode("ascii"),
                                           int(100 * scores[i]))
            color = colors[hash(class_names[i]) % len(colors)]
            image_pil = Image.fromarray(np.uint8(image)).convert("RGB")
            draw_bounding_box_on_image(
                image_pil,
                ymin,
                xmin,
                ymax,
                xmax,
                color,
                font,
                display_str_list=[display_str])
            np.copyto(image, np.array(image_pil))

    return image

def load_img(path):

```

```



```

```
# print(f'Original: Inference time: {end_time-start_time}')
```

```
image_with_boxes = draw_boxes(
    single_img.numpy(),
    result["detection_boxes"],
    result["detection_class_entities"],
    result["detection_scores"])
scores = result['detection_scores']
top_10_scores = np.sort(np.array(scores))[-9:]
detection_avg = np.mean(top_10_scores)
detection_score = f'{titles[0]} - Average Object Score = {detection_avg}'

image_filename = paths[0][-8:]
image_with_objects_path = 'original_objects'
save_path = os.path.join(image_with_objects_path, image_filename)
cv2.imwrite(save_path, image_with_boxes)

images.append(image_with_boxes)
_data = {
    'top_10_scores': top_10_scores,
    'original': True
}
data.append(_data.copy())
display_image(images, data)
return data
```

3. Test

Let's test the object detection model on our original CCTV footage. We measure the average confidence score of the top 10 objects detected in each image.

In [18]:

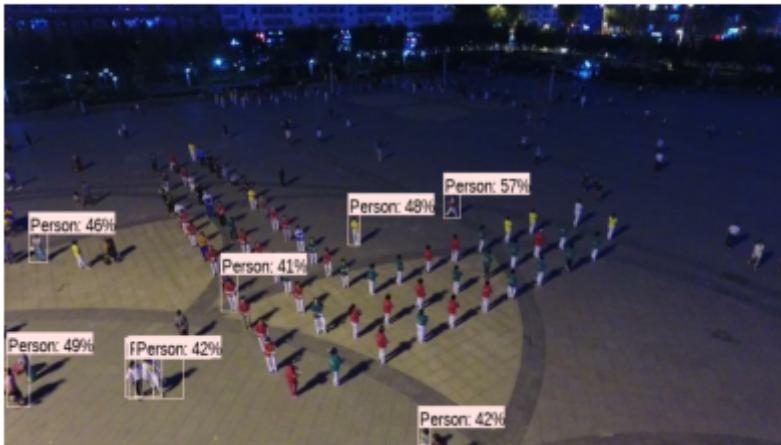
```
path = original_path
input_list = sorted(glob.glob(os.path.join(path, '*')))
number_of_frames = len(input_list)
data = []

for frame_num, input_path in enumerate(input_list):

    if frame_num == 0:
        print('First inference may take 1-2 minutes...')
    print(f'Frame or Image {frame_num + 1}/{number_of_frames}')
    print(f'Path: {input_path}')
    _data = run_detector([input_path], ['Original'])
    data.append(_data)
```

```
First inference may take 1-2 minutes...
Frame or Image 1/50
Path: drive/MyDrive/Data/train_tiny/images/0000036_00500_d_0000046.jpg
```

Average object score = 0.48066630959510803



Frame or Image 2/50

Path: drive/MyDrive/Data/train_tiny/images/0000039_05625_d_0000062.jpg

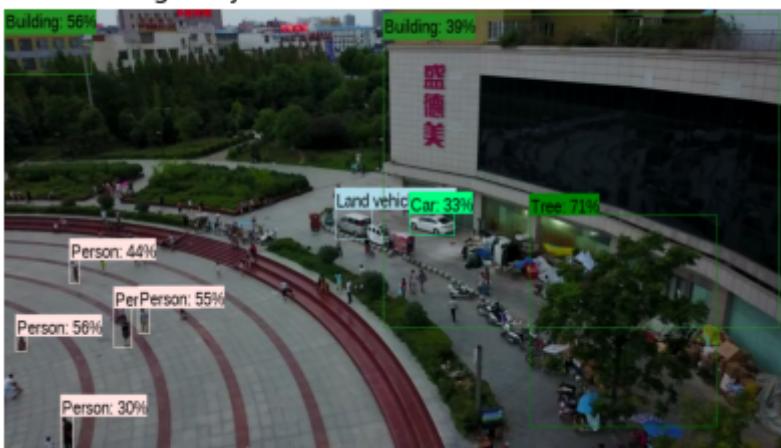
Average object score = 0.6458337306976318



Frame or Image 3/50

Path: drive/MyDrive/Data/train_tiny/images/0000042_02421_d_0000076.jpg

Average object score = 0.5097763538360596



Frame or Image 4/50

Path: drive/MyDrive/Data/train_tiny/images/0000047_03500_d_0000095.jpg

Average object score = 0.3754555284976959



Frame or Image 5/50

Path: drive/MyDrive/Data/train_tiny/images/0000071_02729_d_0000002.jpg

Average object score = 0.7077203989028931



Frame or Image 6/50

Path: drive/MyDrive/Data/train_tiny/images/0000071_03470_d_0000005.jpg

Average object score = 0.8419745564460754



Frame or Image 7/50

Path: drive/MyDrive/Data/train_tiny/images/0000071_04085_d_0000007.jpg

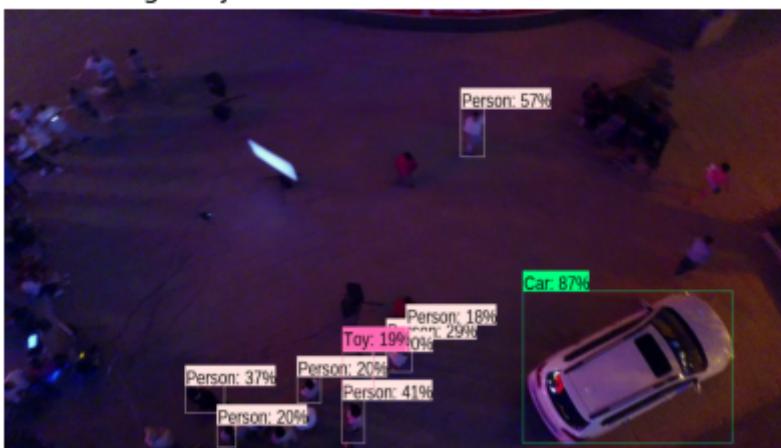
Average object score = 0.7498303651809692



Frame or Image 8/50

Path: drive/MyDrive/Data/train_tiny/images/0000071_07913_d_0000013.jpg

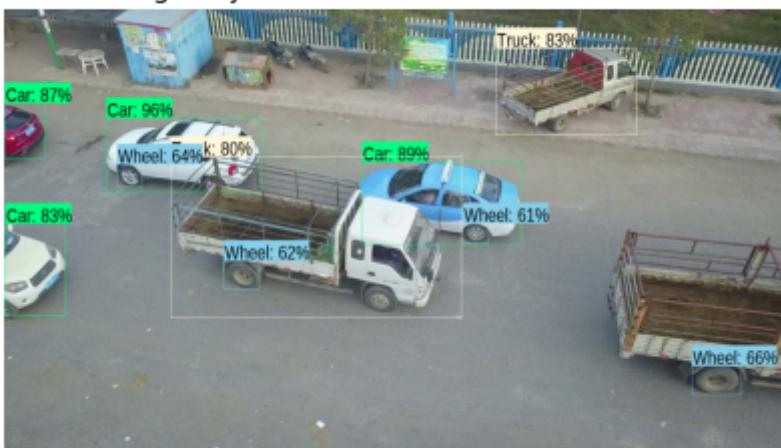
Average object score = 0.37190496921539307



Frame or Image 9/50

Path: drive/MyDrive/Data/train_tiny/images/0000076_00352_d_0000002.jpg

Average object score = 0.7954723834991455



Frame or Image 10/50

Path: drive/MyDrive/Data/train_tiny/images/0000079_01062_d_0000003.jpg

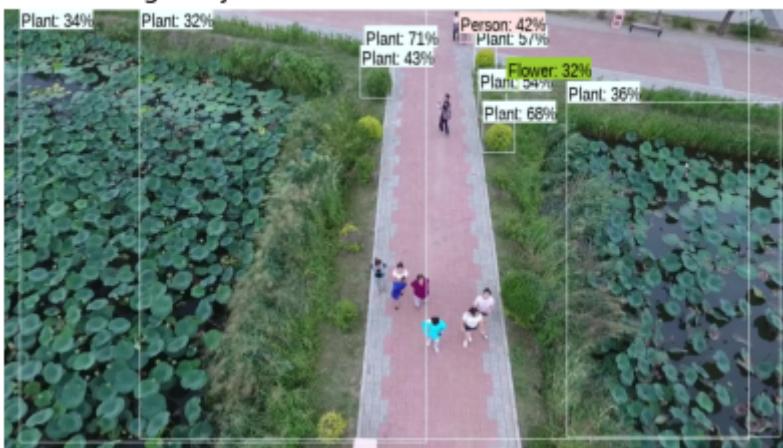
Average object score = 0.7276620268821716



Frame or Image 11/50

Path: drive/MyDrive/Data/train_tiny/images/0000099_04272_d_0000010.jpg

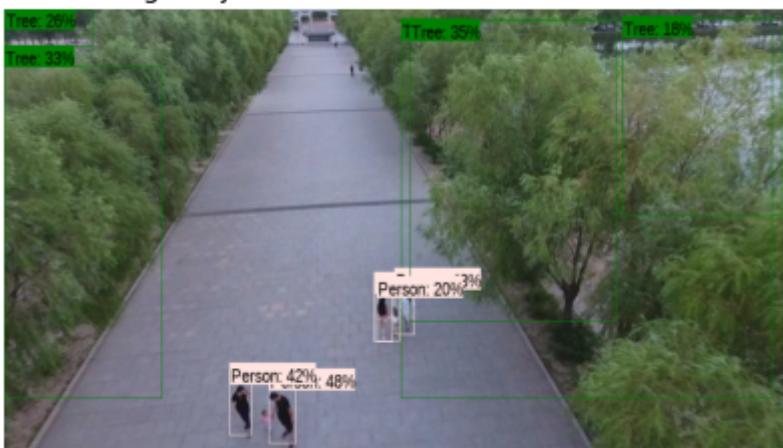
Average object score = 0.49095651507377625



Frame or Image 12/50

Path: drive/MyDrive/Data/train_tiny/images/0000102_00919_d_0000023.jpg

Average object score = 0.41205132007598877



Frame or Image 13/50

Path: drive/MyDrive/Data/train_tiny/images/0000106_00294_d_0000048.jpg

Average object score = 0.4133661687374115



Frame or Image 14/50

Path: drive/MyDrive/Data/train_tiny/images/0000114_00461_d_0000079.jpg

Average object score = 0.4042799770832062



Frame or Image 15/50

Path: drive/MyDrive/Data/train_tiny/images/0000123_01819_d_0000120.jpg

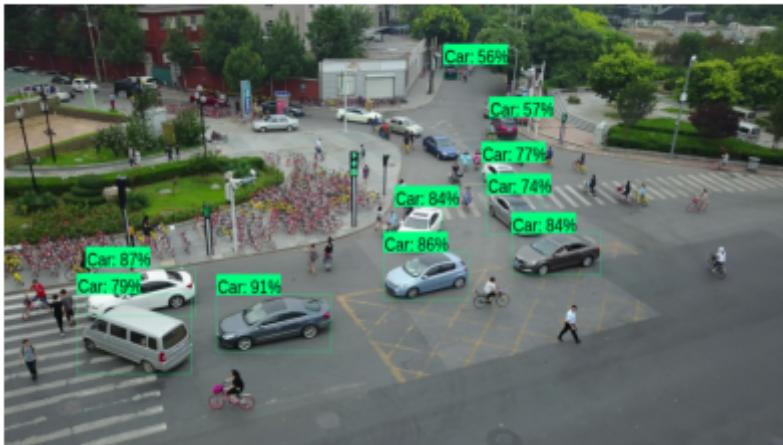
Average object score = 0.5860791802406311



Frame or Image 16/50

Path: drive/MyDrive/Data/train_tiny/images/0000137_00960_d_0000160.jpg

Average object score = 0.8040178418159485



Frame or Image 17/50

Path: drive/MyDrive/Data/train_tiny/images/0000141_00851_d_0000012.jpg

Average object score = 0.46510565280914307



Frame or Image 18/50

Path: drive/MyDrive/Data/train_tiny/images/0000142_02658_d_0000036.jpg

Average object score = 0.5438899993896484



Frame or Image 19/50

Path: drive/MyDrive/Data/train_tiny/images/0000142_04858_d_0000047.jpg

Average object score = 0.5194004774093628



Frame or Image 20/50

Path: drive/MyDrive/Data/train_tiny/images/0000144_00401_d_0000001.jpg

Average object score = 0.5588361024856567



Frame or Image 21/50

Path: drive/MyDrive/Data/train_tiny/images/0000165_00525_d_0000086.jpg

Average object score = 0.6886068585253479



Frame or Image 22/50

Path: drive/MyDrive/Data/train_tiny/images/0000165_02725_d_0000097.jpg

Average object score = 0.6535471081733704



Frame or Image 23/50

Path: drive/MyDrive/Data/train_tiny/images/0000165_06125_d_0000114.jpg

Average object score = 0.6292893290519714



Frame or Image 24/50

Path: drive/MyDrive/Data/train_tiny/images/0000172_00001_d_0000001.jpg

Average object score = 0.5588535070419312



Frame or Image 25/50

Path: drive/MyDrive/Data/train_tiny/images/0000176_00401_d_0000001.jpg

Average object score = 0.6235794425010681



Frame or Image 26/50

Path: drive/MyDrive/Data/train_tiny/images/0000179_00445_d_0000016.jpg

Average object score = 0.3247097432613373



Frame or Image 27/50

Path: drive/MyDrive/Data/train_tiny/images/0000180_01213_d_0000025.jpg

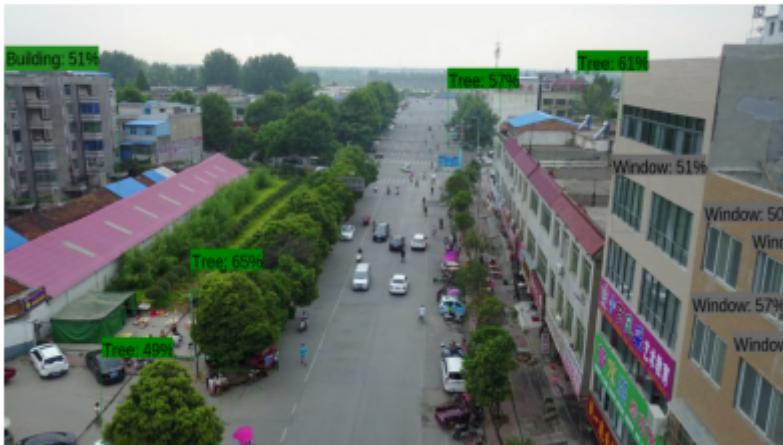
Average object score = 0.3428623378276825



Frame or Image 28/50

Path: drive/MyDrive/Data/train_tiny/images/0000195_01040_d_0000131.jpg

Average object score = 0.5663140416145325



Frame or Image 29/50

Path: drive/MyDrive/Data/train_tiny/images/0000197_00401_d_0000147.jpg

Average object score = 0.5668959021568298



Frame or Image 30/50

Path: drive/MyDrive/Data/train_tiny/images/0000197_00851_d_0000148.jpg

Average object score = 0.47165822982788086



Frame or Image 31/50

Path: drive/MyDrive/Data/train_tiny/images/0000197_01661_d_0000150.jpg

Average object score = 0.5455425381660461



Frame or Image 32/50

Path: drive/MyDrive/Data/train_tiny/images/0000204_00000_d_0000191.jpg

Average object score = 0.4755869507789612



Frame or Image 33/50

Path: drive/MyDrive/Data/train_tiny/images/0000205_01665_d_0000200.jpg

Average object score = 0.4865994453430176



Frame or Image 34/50

Path: drive/MyDrive/Data/train_tiny/images/0000209_00296_d_0000220.jpg

Average object score = 0.548641562461853



Frame or Image 35/50

Path: drive/MyDrive/Data/train_tiny/images/0000210_01551_d_0000228.jpg

Average object score = 0.4717409312725067



Frame or Image 36/50

Path: drive/MyDrive/Data/train_tiny/images/0000218_00001_d_0000001.jpg

Average object score = 0.2682665288448334



Frame or Image 37/50

Path: drive/MyDrive/Data/train_tiny/images/0000220_02658_d_0000008.jpg

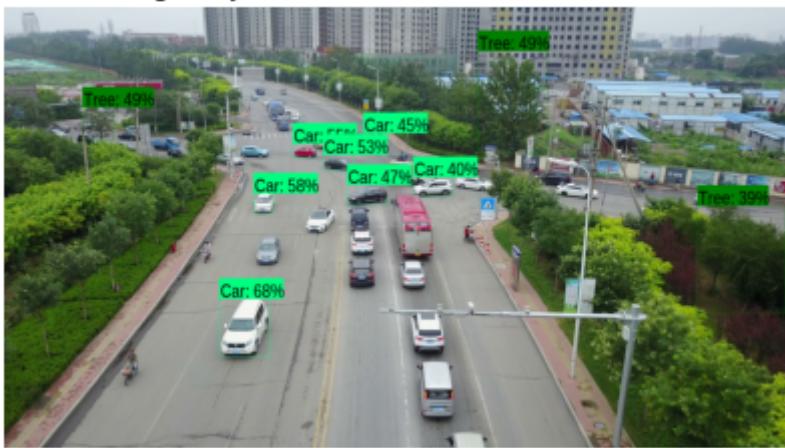
Average object score = 0.59098881483078



Frame or Image 38/50

Path: drive/MyDrive/Data/train_tiny/images/0000222_02900_d_0000009.jpg

Average object score = 0.5223292708396912



Frame or Image 39/50

Path: drive/MyDrive/Data/train_tiny/images/0000223_00836_d_0000003.jpg

Average object score = 0.5376542806625366



Frame or Image 40/50

Path: drive/MyDrive/Data/train_tiny/images/0000225_00001_d_0000001.jpg

Average object score = 0.5590221881866455



Frame or Image 41/50

Path: drive/MyDrive/Data/train_tiny/images/0000227_00001_d_0000001.jpg

Average object score = 0.6192705631256104



Frame or Image 42/50

Path: drive/MyDrive/Data/train_tiny/images/0000236_00811_d_0000003.jpg

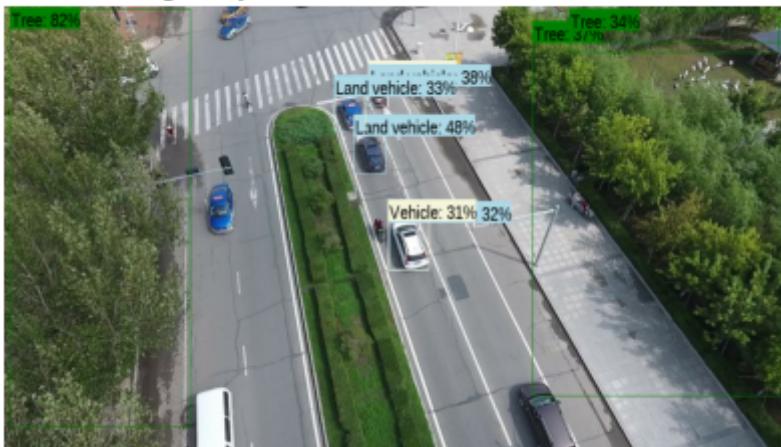
Average object score = 0.5320387482643127



Frame or Image 43/50

Path: drive/MyDrive/Data/train_tiny/images/0000239_00708_d_0000003.jpg

Average object score = 0.443218857049942



Frame or Image 44/50

Path: drive/MyDrive/Data/train_tiny/images/0000239_02531_d_0000008.jpg

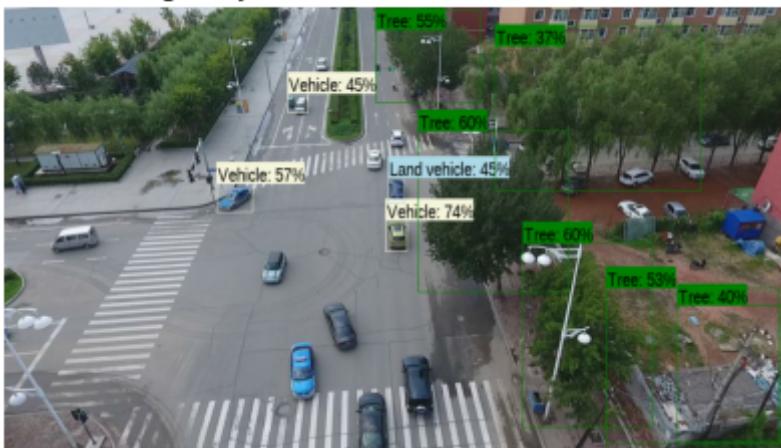
Average object score = 0.5580561757087708



Frame or Image 45/50

Path: drive/MyDrive/Data/train_tiny/images/0000239_04052_d_0000012.jpg

Average object score = 0.548581063747406



Frame or Image 46/50

Path: drive/MyDrive/Data/train_tiny/images/0000239_05950_d_0000016.jpg

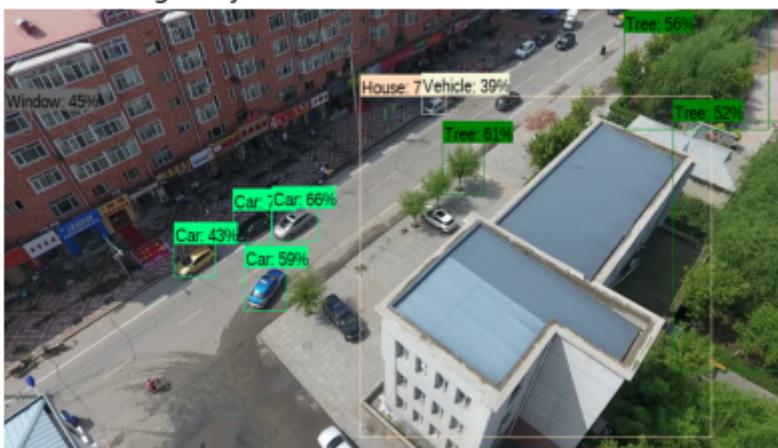
Average object score = 0.5913296937942505



Frame or Image 47/50

Path: drive/MyDrive/Data/train_tiny/images/0000240_03011_d_0000008.jpg

Average object score = 0.5931519269943237



Frame or Image 48/50

Path: drive/MyDrive/Data/train_tiny/images/0000243_01500_d_0000004.jpg

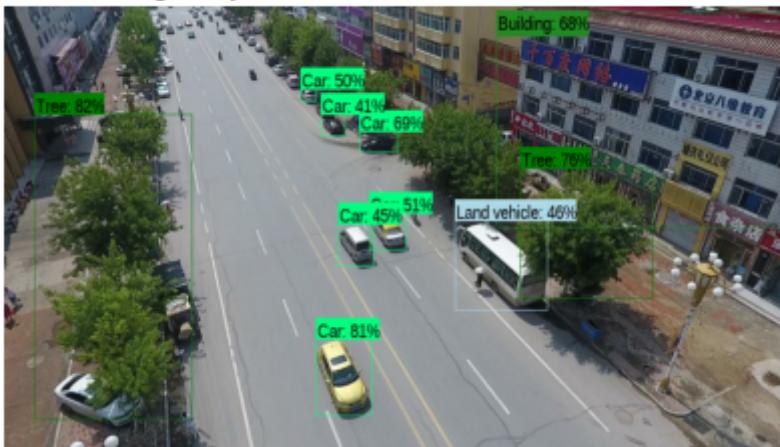
Average object score = 0.5762314200401306



Frame or Image 49/50

Path: drive/MyDrive/Data/train_tiny/images/0000252_00499_d_0000002.jpg

Average object score = 0.6351220607757568



Frame or Image 50/50

Path: drive/MyDrive/Data/train_tiny/images/0000256_04356_d_0000036.jpg

Average object score = 0.4693044424057007



Display Small Sample

Even with low-quality footage, we manage to extract a large amount of detail about the objects present in individual frames. However, most CCTV footage is of extremely low resolution, might artificial image enhancement improve upon our existing object detection scores?

In [19]:

```

path = original_path
original_list = sorted(glob.glob(os.path.join(path, '*')))
frames_to_process = len(original_list)

leading_characters_trim = 9
if dataset == 'image':
    leading_characters_trim = len('drive/MyDrive/Data/train/images') + 1
elif dataset == 'image_small':
    leading_characters_trim = len('drive/MyDrive/Data/train_small/images') + 1
elif dataset == 'image_tiny':
    leading_characters_trim = len('drive/MyDrive/Data/train_tiny/images') + 1
else:
    leading_characters_trim = len('original') + 1

for frame_num, original_image_path in enumerate(original_list):
    original_output = 'masked/original/' + original_image_path[leading_characters_
    print(f'Processing Frame or Image: {frame_num + 1}/{frames_to_process}')

```

```
img_original = imread(original_image_path)
original_result = inference_detector(model, img_original)
model.show_result(img_original, original_result, out_file=original_output)
```

Processing Frame or Image: 1/50

/usr/local/lib/python3.7/site-packages/mmdet/datasets/utils.py:69: UserWarning:
"ImageToTensor" pipeline is replaced by "DefaultFormatBundle" for batch inference.
It is recommended to manually replace it in the test data pipeline in your config file.

'data pipeline in your config file.', UserWarning)

Processing Frame or Image: 2/50

Processing Frame or Image: 3/50

Processing Frame or Image: 4/50

Processing Frame or Image: 5/50

Processing Frame or Image: 6/50

Processing Frame or Image: 7/50

Processing Frame or Image: 8/50

Processing Frame or Image: 9/50

Processing Frame or Image: 10/50

Processing Frame or Image: 11/50

Processing Frame or Image: 12/50

Processing Frame or Image: 13/50

Processing Frame or Image: 14/50

Processing Frame or Image: 15/50

Processing Frame or Image: 16/50

Processing Frame or Image: 17/50

Processing Frame or Image: 18/50

Processing Frame or Image: 19/50

Processing Frame or Image: 20/50

Processing Frame or Image: 21/50

Processing Frame or Image: 22/50

Processing Frame or Image: 23/50

Processing Frame or Image: 24/50

Processing Frame or Image: 25/50

Processing Frame or Image: 26/50

Processing Frame or Image: 27/50

Processing Frame or Image: 28/50

Processing Frame or Image: 29/50

Processing Frame or Image: 30/50

Processing Frame or Image: 31/50

Processing Frame or Image: 32/50

Processing Frame or Image: 33/50

Processing Frame or Image: 34/50

Processing Frame or Image: 35/50

Processing Frame or Image: 36/50

Processing Frame or Image: 37/50

Processing Frame or Image: 38/50

Processing Frame or Image: 39/50

Processing Frame or Image: 40/50

Processing Frame or Image: 41/50

Processing Frame or Image: 42/50

Processing Frame or Image: 43/50

Processing Frame or Image: 44/50

Processing Frame or Image: 45/50

Processing Frame or Image: 46/50

Processing Frame or Image: 47/50

Processing Frame or Image: 48/50

Processing Frame or Image: 49/50

Processing Frame or Image: 50/50

Display Small Sample of Result

In [20]:

```
original_masked_path = 'masked/original'
```

```

original_masked_list = sorted(glob.glob(os.path.join(original_masked_path, '*')))
frames_to_process = len(original_masked_list)

frames = random.sample(original_masked_list, 5)
for path in frames:
    img_output = imread(path)
    root_path_length = len(original_masked_path) + 1
    frame_selected = path[root_path_length:-4].strip('0')

    print(f'Frame or Image {frame_selected}/{frames_to_process}')
    display_image([img_output], ["Original - RCNN Masked"])

```

Frame or Image 36_00500_d_0000046/50

Original - RCNN Masked



Frame or Image 239_05950_d_0000016/50

Original - RCNN Masked



Frame or Image 239_02531_d_0000008/50

Original - RCNN Masked



Frame or Image 240_03011_d_0000008/50

Original - RCNN Masked



Frame or Image 197_00851_d_0000148/50

Original - RCNN Masked



Object Detection - *Post-Enhancement*

Now we will examine what happens when we upscale and enhance the frames prior to performing object detection.

Let's first update the path to our CCTV footage.

```
In [21]: original_path = '../original'
```

```
enhanced_path = '../enhanced'
```

1. Image enhancement using Real-ESRGAN

We used TencentARC's [Real-ESRGAN](#) for image enhancement and upscaling, improving the quality of low-resolution images which frames of CCTV footage usually are.

Load Real-ESRGAN

In [22]:

```
# Clone Real-ESRGAN and enter the Real-ESRGAN
!git clone https://github.com/xinntao/Real-ESRGAN.git
%cd Real-ESRGAN
# Set up the environment
!pip install basicsr
!pip install faceclib
!pip install gfpgan
!pip install -r requirements.txt
!python setup.py develop
# Download the pre-trained model
!wget https://github.com/xinntao/Real-ESRGAN/releases/download/v0.1.0/RealeSRGAN
%cd ..
```

```
Cloning into 'Real-ESRGAN'...
remote: Enumerating objects: 558, done.
remote: Counting objects: 100% (46/46), done.
remote: Compressing objects: 100% (29/29), done.
remote: Total 558 (delta 22), reused 28 (delta 14), pack-reused 512
Receiving objects: 100% (558/558), 4.64 MiB | 18.14 MiB/s, done.
Resolving deltas: 100% (284/284), done.
/content/Real-ESRGAN
Collecting basicsr
    Downloading basicsr-1.3.4.9.tar.gz (161 kB)
    [██████████] 161 kB 6.9 MB/s
Requirement already satisfied: addict in /usr/local/lib/python3.7/site-packages
(from basicsr) (2.4.0)
Collecting future
    Downloading future-0.18.2.tar.gz (829 kB)
    [██████████] 829 kB 78.5 MB/s
Collecting lmdb
    Downloading lmdb-1.2.1-cp37-cp37m-manylinux2010_x86_64.whl (299 kB)
    [██████████] 299 kB 87.5 MB/s
Requirement already satisfied: numpy in /usr/local/lib/python3.7/site-packages
(from basicsr) (1.21.2)
Requirement already satisfied: opencv-python in /usr/local/lib/python3.7/site-pa
ckages (from basicsr) (4.5.4.60)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/site-packages
(from basicsr) (8.4.0)
Requirement already satisfied: pyyaml in /usr/local/lib/python3.7/site-packages
(from basicsr) (6.0)
Requirement already satisfied: requests in /usr/local/lib/python3.7/site-package
s (from basicsr) (2.26.0)
Collecting scikit-image
    Downloading scikit_image-0.19.1-cp37-cp37m-manylinux_2_12_x86_64.manylinux2010
_x86_64.whl (13.3 MB)
    [██████████] 13.3 MB 95.4 MB/s
Collecting scipy
    Downloading scipy-1.7.3-cp37-cp37m-manylinux_2_12_x86_64.manylinux2010_x86_64.
whl (38.1 MB)
    [██████████] 38.1 MB 1.4 MB/s
Collecting tb-nightly
```

```
        Downloading tb_nightly-2.8.0a20211221-py3-none-any.whl (5.8 MB)
|██████████| 5.8 MB 63.3 MB/s
Requirement already satisfied: torch>=1.7 in /usr/local/lib/python3.7/site-packages (from basicsr) (1.10.1)
Requirement already satisfied: torchvision in /usr/local/lib/python3.7/site-packages (from basicsr) (0.11.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/site-packages (from basicsr) (4.62.3)
Requirement already satisfied: yapf in /usr/local/lib/python3.7/site-packages (from basicsr) (0.31.0)
Requirement already satisfied: typing_extensions in /usr/local/lib/python3.7/site-packages (from torch>=1.7->basicsr) (3.10.0.2)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/site-packages (from requests->basicsr) (2021.10.8)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/site-packages (from requests->basicsr) (3.3)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.7/site-packages (from requests->basicsr) (1.26.7)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.7/site-packages (from requests->basicsr) (2.0.4)
Collecting tifffile>=2019.7.26
    Downloading tifffile-2021.11.2-py3-none-any.whl (178 kB)
|██████████| 178 kB 92.6 MB/s
Collecting PyWavelets>=1.1.1
    Downloading PyWavelets-1.2.0-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.whl (6.1 MB)
|██████████| 6.1 MB 72.0 MB/s
Collecting imageio>=2.4.1
    Downloading imageio-2.13.4-py3-none-any.whl (3.3 MB)
|██████████| 3.3 MB 90.5 MB/s
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/site-packages (from scikit-image->basicsr) (21.3)
Collecting networkx>=2.2
    Downloading networkx-2.6.3-py3-none-any.whl (1.9 MB)
|██████████| 1.9 MB 25.7 MB/s
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/site-packages (from packaging>=20.0->scikit-image->basicsr) (3.0.6)
Collecting tensorboard-data-server<0.7.0,>=0.6.0
    Downloading tensorboard_data_server-0.6.1-py3-none-manylinux2010_x86_64.whl (4.9 MB)
|██████████| 4.9 MB 62.6 MB/s
Collecting absl-py>=0.4
    Downloading absl_py-1.0.0-py3-none-any.whl (126 kB)
|██████████| 126 kB 79.9 MB/s
Requirement already satisfied: setuptools>=41.0.0 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicsr) (58.0.4)
Collecting google-auth-oauthlib<0.5,>=0.4.1
    Downloading google_auth_oauthlib-0.4.6-py2.py3-none-any.whl (18 kB)
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicsr) (3.3.6)
Collecting google-auth<3,>=1.6.3
    Downloading google_auth-2.3.3-py2.py3-none-any.whl (155 kB)
|██████████| 155 kB 103.4 MB/s
Collecting werkzeug>=0.11.15
    Downloading Werkzeug-2.0.2-py3-none-any.whl (288 kB)
|██████████| 288 kB 75.3 MB/s
Requirement already satisfied: wheel>=0.26 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicsr) (0.37.0)
Collecting grpcio>=1.24.3
    Downloading grpcio-1.43.0-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (4.1 MB)
|██████████| 4.1 MB 54.6 MB/s
Collecting tensorboard-plugin-wit>=1.6.0
    Downloading tensorboard_plugin_wit-1.8.0-py3-none-any.whl (781 kB)
|██████████| 781 kB 91.0 MB/s
```

```
Collecting protobuf>=3.6.0
  Downloading protobuf-3.19.1-cp37-cp37m-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.1 MB)
    [██████████] 1.1 MB 71.6 MB/s
Requirement already satisfied: six in /usr/local/lib/python3.7/site-packages (from absl-py>=0.4->tb-nightly->basicr) (1.16.0)
Collecting cachetools<5.0,>=2.0.0
  Downloading cachetools-4.2.4-py3-none-any.whl (10 kB)
Collecting rsa<5,>=3.1.4
  Downloading rsa-4.8-py3-none-any.whl (39 kB)
Collecting pyasn1-modules>=0.2.1
  Downloading pyasn1_modules-0.2.8-py2.py3-none-any.whl (155 kB)
    [██████████] 155 kB 94.8 MB/s
Collecting requests-oauthlib>=0.7.0
  Downloading requests_oauthlib-1.3.0-py2.py3-none-any.whl (23 kB)
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python3.7/site-packages (from markdown>=2.6.8->tb-nightly->basicr) (4.10.0)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/site-packages (from importlib-metadata>=4.4->markdown>=2.6.8->tb-nightly->basicr) (3.6.0)
Collecting pyasn1<0.5.0,>=0.4.6
  Downloading pyasn1-0.4.8-py2.py3-none-any.whl (77 kB)
    [██████████] 77 kB 7.5 MB/s
Collecting oauthlib>=3.0.0
  Downloading oauthlib-3.1.1-py2.py3-none-any.whl (146 kB)
    [██████████] 146 kB 99.1 MB/s
Building wheels for collected packages: basicr, future
  Building wheel for basicr (setup.py) ... done
    Created wheel for basicr: filename=basicsr-1.3.4.9-py3-none-any.whl size=1944
39 sha256=10c6f8f536b1b03001932028b20ab3ee88c85c4dfad1775f5e65c60f703553a4
  Stored in directory: /root/.cache/pip/wheels/92/52/70/341916b8c102f1e4416695e6
01d4aa71ba34d1080f7aa47cf5
  Building wheel for future (setup.py) ... done
    Created wheel for future: filename=future-0.18.2-py3-none-any.whl size=491070
sha256=51e2c606e6dc49ad2d0925fdcc69115199959b3120e305f34b67dc9884db2686
  Stored in directory: /root/.cache/pip/wheels/56/b0/fe/4410d17b32f1f0c3cf54cdfb
2bc04d7b4b8f4ae377e2229ba0
Successfully built basicsr future
Installing collected packages: pyasn1, rsa, pyasn1-modules, oauthlib, cachetools, requests-oauthlib, google-auth, werkzeug, tifffile, tensorboard-plugin-wit, tensorboard-data-server, scipy, PyWavelets, protobuf, networkx, imageio, grpcio, google-auth-oauthlib, absl-py, tb-nightly, scikit-image, lmdb, future, basicr
Successfully installed PyWavelets-1.2.0 absl-py-1.0.0 basicsr-1.3.4.9 cachetools-4.2.4 future-0.18.2 google-auth-2.3.3 google-auth-oauthlib-0.4.6 grpcio-1.43.0 imageio-2.13.4 lmdb-1.2.1 networkx-2.6.3 oauthlib-3.1.1 protobuf-3.19.1 pyasn1-0.4.8 pyasn1-modules-0.2.8 requests-oauthlib-1.3.0 rsa-4.8 scikit-image-0.19.1 scipy-1.7.3 tb-nightly-2.8.0a20211221 tensorboard-data-server-0.6.1 tensorboard-plugin-wit-1.8.0 tifffile-2021.11.2 werkzeug-2.0.2
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv

Collecting faceplib
  Downloading faceplib-0.2.1.1-py3-none-any.whl (56 kB)
    [██████████] 56 kB 3.5 MB/s
Requirement already satisfied: numpy in /usr/local/lib/python3.7/site-packages (from faceplib) (1.21.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/site-packages (from faceplib) (4.62.3)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/site-packages (from faceplib) (8.4.0)
Requirement already satisfied: opencv-python in /usr/local/lib/python3.7/site-packages (from faceplib) (4.5.4.60)
Requirement already satisfied: torch in /usr/local/lib/python3.7/site-packages (from faceplib) (1.10.1)
Collecting numba
```

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        Downloading numba-0.54.1-cp37-cp37m-manylinux2014_x86_64.manylinux_2_17_x86_6
4.whl (3.3 MB) |██████████| 3.3 MB 14.0 MB/s
Requirement already satisfied: torchvision in /usr/local/lib/python3.7/site-packages (from facexlib) (0.11.2)
Requirement already satisfied: scipy in /usr/local/lib/python3.7/site-packages (from facexlib) (1.7.3)
Collecting filterpy
    Downloading filterpy-1.4.5.zip (177 kB) |██████████| 177 kB 74.0 MB/s
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/site-packages (from filterpy->facexlib) (3.5.1)
Requirement already satisfied: pyparsing>=2.2.1 in /usr/local/lib/python3.7/site-packages (from matplotlib->filterpy->facexlib) (3.0.6)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/site-packages (from matplotlib->filterpy->facexlib) (1.3.2)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.7/site-packages (from matplotlib->filterpy->facexlib) (4.28.5)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.7/site-packages (from matplotlib->filterpy->facexlib) (2.8.2)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/site-packages (from matplotlib->filterpy->facexlib) (21.3)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/site-packages (from matplotlib->filterpy->facexlib) (0.11.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-packages (from python-dateutil>=2.7->matplotlib->filterpy->facexlib) (1.16.0)
Collecting numpy
    Downloading numpy-1.20.3-cp37-cp37m-manylinux_2_12_x86_64.manylinux2010_x86_6
4.whl (15.3 MB) |██████████| 15.3 MB 78.3 MB/s
Collecting llvmlite<0.38,>=0.37.0rc1
    Downloading llvmlite-0.37.0-cp37-cp37m-manylinux2014_x86_64.whl (26.3 MB) |██████████| 26.3 MB 1.3 MB/s
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/site-packages (from numba->facexlib) (58.0.4)
Requirement already satisfied: typing_extensions in /usr/local/lib/python3.7/site-packages (from torch->facexlib) (3.10.0.2)
Building wheels for collected packages: filterpy
    Building wheel for filterpy (setup.py) ... done
    Created wheel for filterpy: filename=filterpy-1.4.5-py3-none-any.whl size=1104
74 sha256=22ebaf4fbfb538b6b690a86e2079b93d9fda793fd864aadce8cf03a0a56e54a2
    Stored in directory: /root/.cache/pip/wheels/ce/e0/ee/a2b3c5caab3418c1cccd8c4de
573d4cbe13315d7e8b0a55fbc2
Successfully built filterpy
Installing collected packages: numpy, llvmlite, numba, filterpy, facexlib
Attempting uninstall: numpy
    Found existing installation: numpy 1.21.2
    Uninstalling numpy-1.21.2:
        Successfully uninstalled numpy-1.21.2
Successfully installed facexlib-0.2.1.1 filterpy-1.4.5 llvmlite-0.37.0 numba-0.5
4.1 numpy-1.20.3
WARNING: Running pip as the 'root' user can result in broken permissions and con
flicting behaviour with the system package manager. It is recommended to use a v
irtual environment instead: https://pip.pypa.io/warnings/venv
Collecting gfgan
    Downloading gfgan-0.2.4-py3-none-any.whl (38 kB)
Requirement already satisfied: numpy<1.21 in /usr/local/lib/python3.7/site-packages (from gfgan) (1.20.3)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/site-packages (f
rom gfgan) (4.62.3)
Requirement already satisfied: lmdb in /usr/local/lib/python3.7/site-packages (f
rom gfgan) (1.2.1)
Requirement already satisfied: facexlib>=0.2.0.3 in /usr/local/lib/python3.7/site-packages (from gfgan) (0.2.1.1)
Requirement already satisfied: tb-nightly in /usr/local/lib/python3.7/site-packages
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ges (from gfpgan) (2.8.0a20211221)
Requirement already satisfied: pyyaml in /usr/local/lib/python3.7/site-packages
  (from gfpgan) (6.0)
Requirement already satisfied: scipy in /usr/local/lib/python3.7/site-packages
  (from gfpgan) (1.7.3)
Requirement already satisfied: torchvision in /usr/local/lib/python3.7/site-packages
  (from gfpgan) (0.11.2)
Requirement already satisfied: torch>=1.7 in /usr/local/lib/python3.7/site-packages
  (from gfpgan) (1.10.1)
Requirement already satisfied: basicsr>=1.3.4.0 in /usr/local/lib/python3.7/site-
  packages (from gfpgan) (1.3.4.9)
Requirement already satisfied: yapf in /usr/local/lib/python3.7/site-packages (f
  rom gfpgan) (0.31.0)
Requirement already satisfied: opencv-python in /usr/local/lib/python3.7/site-pa
  ckages (from gfpgan) (4.5.4.60)
Requirement already satisfied: addict in /usr/local/lib/python3.7/site-packages
  (from basicsr>=1.3.4.0->gfpgan) (2.4.0)
Requirement already satisfied: future in /usr/local/lib/python3.7/site-packages
  (from basicsr>=1.3.4.0->gfpgan) (0.18.2)
Requirement already satisfied: scikit-image in /usr/local/lib/python3.7/site-pac
  kages (from basicsr>=1.3.4.0->gfpgan) (0.19.1)
Requirement already satisfied: requests in /usr/local/lib/python3.7/site-package
  s (from basicsr>=1.3.4.0->gfpgan) (2.26.0)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/site-packages
  (from basicsr>=1.3.4.0->gfpgan) (8.4.0)
Requirement already satisfied: numba in /usr/local/lib/python3.7/site-packages
  (from facecplib>=0.2.0.3->gfpgan) (0.54.1)
Requirement already satisfied: filterpy in /usr/local/lib/python3.7/site-package
  s (from facecplib>=0.2.0.3->gfpgan) (1.4.5)
Requirement already satisfied: typing_extensions in /usr/local/lib/python3.7/sit
  e-packages (from torch>=1.7->gfpgan) (3.10.0.2)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/site-pac
  kages (from filterpy->facecplib>=0.2.0.3->gfpgan) (3.5.1)
Requirement already satisfied: pyparsing>=2.2.1 in /usr/local/lib/python3.7/site
  -packages (from matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan) (3.0.6)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.7/
  site-packages (from matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan) (2.8.2)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.7/sit
  e-packages (from matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan) (4.28.5)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/sit
  e-packages (from matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan) (1.3.2)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/site-pac
  kages (from matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan) (0.11.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/site-
  packages (from matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan) (21.3)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-package
  s (from python-dateutil>=2.7->matplotlib->filterpy->facecplib>=0.2.0.3->gfpgan
  ) (1.16.0)
Requirement already satisfied: llvmlite<0.38,>=0.37.0rc1 in /usr/local/lib/pytho
  n3.7/site-packages (from numba->facecplib>=0.2.0.3->gfpgan) (0.37.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/site-pac
  kages (from numba->facecplib>=0.2.0.3->gfpgan) (58.0.4)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/site-pac
  kages (from requests->basicsr>=1.3.4.0->gfpgan) (3.3)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/pytho
  n3.7/site-packages (from requests->basicsr>=1.3.4.0->gfpgan) (2.0.4)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/si
  te-packages (from requests->basicsr>=1.3.4.0->gfpgan) (2021.10.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.
  7/site-packages (from requests->basicsr>=1.3.4.0->gfpgan) (1.26.7)
Requirement already satisfied: PyWavelets>=1.1.1 in /usr/local/lib/python3.7/sit
  e-packages (from scikit-image->basicsr>=1.3.4.0->gfpgan) (1.2.0)
Requirement already satisfied: networkx>=2.2 in /usr/local/lib/python3.7/site-pa
  ckages (from scikit-image->basicsr>=1.3.4.0->gfpgan) (2.6.3)
Requirement already satisfied: tifffile>=2019.7.26 in /usr/local/lib/python3.7/s
```

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ite-packages (from scikit-image->basicstr>=1.3.4.0->gfpgan) (2021.11.2)
Requirement already satisfied: imageio>=2.4.1 in /usr/local/lib/python3.7/site-p
ackages (from scikit-image->basicstr>=1.3.4.0->gfpgan) (2.13.4)
Requirement already satisfied: tensorflow-plugin-wit>=1.6.0 in /usr/local/lib/p
ython3.7/site-packages (from tb-nightly->gfpgan) (1.8.0)
Requirement already satisfied: protobuf>=3.6.0 in /usr/local/lib/python3.7/site-
packages (from tb-nightly->gfpgan) (3.19.1)
Requirement already satisfied: werkzeug>=0.11.15 in /usr/local/lib/python3.7/sit
e-packages (from tb-nightly->gfpgan) (2.0.2)
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/site-
packages (from tb-nightly->gfpgan) (3.3.6)
Requirement already satisfied: grpcio>=1.24.3 in /usr/local/lib/python3.7/site-p
ackages (from tb-nightly->gfpgan) (1.43.0)
Requirement already satisfied: absl-py>=0.4 in /usr/local/lib/python3.7/site-pac
kages (from tb-nightly->gfpgan) (1.0.0)
Requirement already satisfied: tensorflow-data-server<0.7.0,>=0.6.0 in /usr/loc
al/lib/python3.7/site-packages (from tb-nightly->gfpgan) (0.6.1)
Requirement already satisfied: wheel>=0.26 in /usr/local/lib/python3.7/site-pac
kages (from tb-nightly->gfpgan) (0.37.0)
Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.
7/site-packages (from tb-nightly->gfpgan) (2.3.3)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/li
b/python3.7/site-packages (from tb-nightly->gfpgan) (0.4.6)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.
7/site-packages (from google-auth<3,>=1.6.3->tb-nightly->gfpgan) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.7/site-pa
ckages (from google-auth<3,>=1.6.3->tb-nightly->gfpgan) (4.8)
Requirement already satisfied: cachetools<5.0,>=2.0.0 in /usr/local/lib/python3.
7/site-packages (from google-auth<3,>=1.6.3->tb-nightly->gfpgan) (4.2.4)
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python
3.7/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tb-nightly->gfpgan)
(1.3.0)
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python
3.7/site-packages (from markdown>=2.6.8->tb-nightly->gfpgan) (4.10.0)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/site-pacak
es (from importlib-metadata>=4.4->markdown>=2.6.8->tb-nightly->gfpgan) (3.6.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.7/
site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tb-nightly->gf
pgan) (0.4.8)
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/site-
packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tb-ni
ghtly->gfpgan) (3.1.1)
Installing collected packages: gfpgan
Successfully installed gfpgan-0.2.4
WARNING: Running pip as the 'root' user can result in broken permissions and con
flicting behaviour with the system package manager. It is recommended to use a v
irtual environment instead: https://pip.pypa.io/warnings/venv
Requirement already satisfied: basicstr>=1.3.3.11 in /usr/local/lib/python3.7/sit
e-packages (from -r requirements.txt (line 1)) (1.3.4.9)
Requirement already satisfied: faceplib>=0.2.0.3 in /usr/local/lib/python3.7/sit
e-packages (from -r requirements.txt (line 2)) (0.2.1.1)
Requirement already satisfied: gfpgan>=0.2.1 in /usr/local/lib/python3.7/site-pa
ckages (from -r requirements.txt (line 3)) (0.2.4)
Requirement already satisfied: numpy in /usr/local/lib/python3.7/site-packages
(from -r requirements.txt (line 4)) (1.20.3)
Requirement already satisfied: opencv-python in /usr/local/lib/python3.7/site-pa
ckages (from -r requirements.txt (line 5)) (4.5.4.60)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/site-packages
(from -r requirements.txt (line 6)) (8.4.0)
Requirement already satisfied: torch>=1.7 in /usr/local/lib/python3.7/site-packa
ges (from -r requirements.txt (line 7)) (1.10.1)
Requirement already satisfied: torchvision in /usr/local/lib/python3.7/site-pack
ages (from -r requirements.txt (line 8)) (0.11.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/site-packages (f
rom -r requirements.txt (line 9)) (4.62.3)
```

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Requirement already satisfied: future in /usr/local/lib/python3.7/site-packages  
  (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (0.18.2)  
Requirement already satisfied: lmdb in /usr/local/lib/python3.7/site-packages (f  
rom basicsr>=1.3.3.11->-r requirements.txt (line 1)) (1.2.1)  
Requirement already satisfied: pyyaml in /usr/local/lib/python3.7/site-packages  
  (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (6.0)  
Requirement already satisfied: scipy in /usr/local/lib/python3.7/site-packages  
  (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (1.7.3)  
Requirement already satisfied: yapf in /usr/local/lib/python3.7/site-packages (f  
rom basicsr>=1.3.3.11->-r requirements.txt (line 1)) (0.31.0)  
Requirement already satisfied: requests in /usr/local/lib/python3.7/site-package  
s (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (2.26.0)  
Requirement already satisfied: scikit-image in /usr/local/lib/python3.7/site-pac  
kages (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (0.19.1)  
Requirement already satisfied: tb-nightly in /usr/local/lib/python3.7/site-pac  
kages (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (2.8.0a20211221)  
Requirement already satisfied: addict in /usr/local/lib/python3.7/site-packages  
  (from basicsr>=1.3.3.11->-r requirements.txt (line 1)) (2.4.0)  
Requirement already satisfied: numba in /usr/local/lib/python3.7/site-packages  
  (from faceplib>=0.2.0.3->-r requirements.txt (line 2)) (0.54.1)  
Requirement already satisfied: filterpy in /usr/local/lib/python3.7/site-package  
s (from faceplib>=0.2.0.3->-r requirements.txt (line 2)) (1.4.5)  
Requirement already satisfied: typing_extensions in /usr/local/lib/python3.7/sit  
e-packages (from torch>=1.7->-r requirements.txt (line 7)) (3.10.0.2)  
Requirement already satisfied: matplotlib in /usr/local/lib/python3.7/site-pac  
kages (from filterpy->faceplib>=0.2.0.3->-r requirements.txt (line 2)) (3.5.1)  
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.7/site-  
packages (from matplotlib->filterpy->faceplib>=0.2.0.3->-r requirements.txt (lin  
e 2)) (21.3)  
Requirement already satisfied: pyparsing>=2.2.1 in /usr/local/lib/python3.7/site  
-packages (from matplotlib->filterpy->faceplib>=0.2.0.3->-r requirements.txt (li  
ne 2)) (3.0.6)  
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.7/sit  
e-packages (from matplotlib->filterpy->faceplib>=0.2.0.3->-r requirements.txt (l  
ine 2)) (1.3.2)  
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.7/  
site-packages (from matplotlib->filterpy->faceplib>=0.2.0.3->-r requirements.txt  
(line 2)) (2.8.2)  
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/site-pac  
kages (from matplotlib->filterpy->faceplib>=0.2.0.3->-r requirements.txt (line  
2)) (0.11.0)  
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.7/sit  
e-packages (from matplotlib->filterpy->faceplib>=0.2.0.3->-r requirements.txt (l  
ine 2)) (4.28.5)  
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/site-package  
s (from python-dateutil>=2.7->matplotlib->filterpy->faceplib>=0.2.0.3->-r requir  
ements.txt (line 2)) (1.16.0)  
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/site-pac  
kages (from numba->faceplib>=0.2.0.3->-r requirements.txt (line 2)) (58.0.4)  
Requirement already satisfied: llvmlite<0.38,>=0.37.0rc1 in /usr/local/lib/pytho  
n3.7/site-packages (from numba->faceplib>=0.2.0.3->-r requirements.txt (line 2))  
(0.37.0)  
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/sit  
e-packages (from requests->basicsr>=1.3.3.11->-r requirements.txt (line 1)) (20  
21.10.8)  
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/site-pac  
kages (from requests->basicsr>=1.3.3.11->-r requirements.txt (line 1)) (3.3)  
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.  
7/site-packages (from requests->basicsr>=1.3.3.11->-r requirements.txt (line 1))  
(1.26.7)  
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/pytho  
n3.7/site-packages (from requests->basicsr>=1.3.3.11->-r requirements.txt (line  
1)) (2.0.4)  
Requirement already satisfied: tifffile>=2019.7.26 in /usr/local/lib/python3.7/s  
ite-packages (from scikit-image->basicsr>=1.3.3.11->-r requirements.txt (line
```

```
    1)) (2021.11.2)
Requirement already satisfied: networkx>=2.2 in /usr/local/lib/python3.7/site-packages (from scikit-image->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (2.6.3)
Requirement already satisfied: PyWavelets>=1.1.1 in /usr/local/lib/python3.7/site-packages (from scikit-image->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (1.2.0)
Requirement already satisfied: imageio>=2.4.1 in /usr/local/lib/python3.7/site-packages (from scikit-image->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (2.13.4)
Requirement already satisfied: protobuf>=3.6.0 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (3.19.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (2.3.3)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (1.8.0)
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (3.3.6)
Requirement already satisfied: grpcio>=1.24.3 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (1.43.0)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (0.6.1)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (0.4.6)
Requirement already satisfied: absl-py>=0.4 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (1.0.0)
Requirement already satisfied: wheel>=0.26 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (0.37.0)
Requirement already satisfied: werkzeug>=0.11.15 in /usr/local/lib/python3.7/site-packages (from tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (2.0.2)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.7/site-packages (from google-auth<3,>=1.6.3->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.7/site-packages (from google-auth<3,>=1.6.3->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (4.8)
Requirement already satisfied: cachetools<5.0,>=2.0.0 in /usr/local/lib/python3.7/site-packages (from google-auth<3,>=1.6.3->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (4.2.4)
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.7/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (1.3.0)
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python3.7/site-packages (from markdown>=2.6.8->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (4.10.0)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/site-packages (from importlib-metadata>=4.4->markdown>=2.6.8->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (3.6.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.7/site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (0.4.8)
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tb-nightly->basicstr>=1.3.3.11->-r requirements.txt (line 1)) (3.1.1)
WARNING: Running pip as the 'root' user can result in broken permissions and conflicting behaviour with the system package manager. It is recommended to use a virtual environment instead: https://pip.pypa.io/warnings/venv
```

```
running develop
running egg_info
creating realesrgan.egg-info
writing realesrgan.egg-info/PKG-INFO
writing dependency_links to realesrgan.egg-info/dependency_links.txt
writing requirements to realesrgan.egg-info/requirements.txt
writing top-level names to realesrgan.egg-info/top_level.txt
writing manifest file 'realesrgan.egg-info/SOURCES.txt'
reading manifest file 'realesrgan.egg-info/SOURCES.txt'
reading manifest template 'MANIFEST.in'
adding license file 'LICENSE'
writing manifest file 'realesrgan.egg-info/SOURCES.txt'
running build_ext
Creating /usr/local/lib/python3.7/site-packages/realesrgan.egg-link (link to .)
Adding realesrgan 0.2.3.0 to easy-install.pth file

Installed /content/Real-ESRGAN
Processing dependencies for realesrgan==0.2.3.0
Searching for wheel>=0.26
Reading https://pypi.org/simple/wheel/
Downloading https://files.pythonhosted.org/packages/27/d6/003e593296a85fd6ed616e
d962795b2f87709c3eee2bca4f6d0fe55c6d00/wheel-0.37.1-py2.py3-none-any.whl#sha256=
4bcdcd7d840138086126cd09254dc6195fb4fc6f01c050a1d7236f2630db1d22a
Best match: wheel 0.37.1
Processing wheel-0.37.1-py2.py3-none-any.whl
Installing wheel-0.37.1-py2.py3-none-any.whl to /usr/local/lib/python3.7/site-pa
ckages
Adding wheel 0.37.1 to easy-install.pth file
Installing wheel script to /usr/local/bin

Installed /usr/local/lib/python3.7/site-packages/wheel-0.37.1-py3.7.egg
Searching for urllib3<1.27,>=1.21.1
Reading https://pypi.org/simple/urllib3/
Downloading https://files.pythonhosted.org/packages/af/f4/524415c0744552cce7d8bf
3669af78e8a069514405ea4fcbd0cc44733744/urllib3-1.26.7-py2.py3-none-any.whl#sha25
6=c4fdf4019605b6e5423637e01bc9fe4daef873709a7973e195ceba0a62bbc844
Best match: urllib3 1.26.7
Processing urllib3-1.26.7-py2.py3-none-any.whl
Installing urllib3-1.26.7-py2.py3-none-any.whl to /usr/local/lib/python3.7/site-
packages
Adding urllib3 1.26.7 to easy-install.pth file

Installed /usr/local/lib/python3.7/site-packages/urllib3-1.26.7-py3.7.egg
Searching for tqdm==4.62.3
Best match: tqdm 4.62.3
Adding tqdm 4.62.3 to easy-install.pth file
Installing tqdm script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for torchvision==0.11.2
Best match: torchvision 0.11.2
Adding torchvision 0.11.2 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for torch==1.10.1
Best match: torch 1.10.1
Adding torch 1.10.1 to easy-install.pth file
Installing convert-caffe2-to-onnx script to /usr/local/bin
Installing convert-onnx-to-caffe2 script to /usr/local/bin
Installing torchrun script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for Pillow==8.4.0
Best match: Pillow 8.4.0
Adding Pillow 8.4.0 to easy-install.pth file
```

```
Using /usr/local/lib/python3.7/site-packages
Searching for opencv-python==4.5.4.60
Best match: opencv-python 4.5.4.60
Adding opencv-python 4.5.4.60 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for numpy==1.20.3
Best match: numpy 1.20.3
Adding numpy 1.20.3 to easy-install.pth file
Installing f2py script to /usr/local/bin
Installing f2py3 script to /usr/local/bin
Installing f2py3.7 script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for gfpgan==0.2.4
Best match: gfpgan 0.2.4
Adding gfpgan 0.2.4 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for faceplib==0.2.1.1
Best match: faceplib 0.2.1.1
Adding faceplib 0.2.1.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for basicsr==1.3.4.9
Best match: basicsr 1.3.4.9
Adding basicsr 1.3.4.9 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for typing-extensions==3.10.0.2
Best match: typing-extensions 3.10.0.2
Adding typing-extensions 3.10.0.2 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for scipy==1.7.3
Best match: scipy 1.7.3
Adding scipy 1.7.3 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for yapf==0.31.0
Best match: yapf 0.31.0
Adding yapf 0.31.0 to easy-install.pth file
Installing yapf script to /usr/local/bin
Installing yapf-diff script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for PyYAML==6.0
Best match: PyYAML 6.0
Adding PyYAML 6.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for tb-nightly==2.8.0a20211221
Best match: tb-nightly 2.8.0a20211221
Adding tb-nightly 2.8.0a20211221 to easy-install.pth file
Installing tensorboard script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for lmdb==1.2.1
Best match: lmdb 1.2.1
Adding lmdb 1.2.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for filterpy==1.4.5
Best match: filterpy 1.4.5
```

```
Adding filterpy 1.4.5 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for numba==0.54.1
Best match: numba 0.54.1
Adding numba 0.54.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for requests==2.26.0
Best match: requests 2.26.0
Adding requests 2.26.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for addict==2.4.0
Best match: addict 2.4.0
Adding addict 2.4.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for future==0.18.2
Best match: future 0.18.2
Adding future 0.18.2 to easy-install.pth file
Installing futurize script to /usr/local/bin
Installing pasteurize script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for scikit-image==0.19.1
Best match: scikit-image 0.19.1
Adding scikit-image 0.19.1 to easy-install.pth file
Installing skivi script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for grpcio==1.43.0
Best match: grpcio 1.43.0
Adding grpcio 1.43.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for tensorboard-plugin-wit==1.8.0
Best match: tensorboard-plugin-wit 1.8.0
Adding tensorboard-plugin-wit 1.8.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for google-auth-oauthlib==0.4.6
Best match: google-auth-oauthlib 0.4.6
Adding google-auth-oauthlib 0.4.6 to easy-install.pth file
Installing google-oauthlib-tool script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for absl-py==1.0.0
Best match: absl-py 1.0.0
Adding absl-py 1.0.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for Markdown==3.3.6
Best match: Markdown 3.3.6
Adding Markdown 3.3.6 to easy-install.pth file
Installing markdown_py script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for protobuf==3.19.1
Best match: protobuf 3.19.1
Adding protobuf 3.19.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for Werkzeug==2.0.2
Best match: Werkzeug 2.0.2
```

```
Adding Werkzeug 2.0.2 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for tensorboard-data-server==0.6.1
Best match: tensorboard-data-server 0.6.1
Adding tensorboard-data-server 0.6.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for setuptools==58.0.4
Best match: setuptools 58.0.4
Adding setuptools 58.0.4 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for google-auth==2.3.3
Best match: google-auth 2.3.3
Adding google-auth 2.3.3 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for matplotlib==3.5.1
Best match: matplotlib 3.5.1
Adding matplotlib 3.5.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for llvmlite==0.37.0
Best match: llvmlite 0.37.0
Adding llvmlite 0.37.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for idna==3.3
Best match: idna 3.3
Adding idna 3.3 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for charset-normalizer==2.0.4
Best match: charset-normalizer 2.0.4
Adding charset-normalizer 2.0.4 to easy-install.pth file
Installing normalizer script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for certifi==2021.10.8
Best match: certifi 2021.10.8
Adding certifi 2021.10.8 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for imageio==2.13.4
Best match: imageio 2.13.4
Adding imageio 2.13.4 to easy-install.pth file
Installing imageio_download_bin script to /usr/local/bin
Installing imageio_remove_bin script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for tifffile==2021.11.2
Best match: tifffile 2021.11.2
Adding tifffile 2021.11.2 to easy-install.pth file
Installing lsm2bin script to /usr/local/bin
Installing tiff2fsspec script to /usr/local/bin
Installing tiffcomment script to /usr/local/bin
Installing tifffile script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for PyWavelets==1.2.0
Best match: PyWavelets 1.2.0
Adding PyWavelets 1.2.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
```

```
Searching for packaging==21.3
Best match: packaging 21.3
Adding packaging 21.3 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for networkx==2.6.3
Best match: networkx 2.6.3
Adding networkx 2.6.3 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for six==1.16.0
Best match: six 1.16.0
Adding six 1.16.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for requests-oauthlib==1.3.0
Best match: requests-oauthlib 1.3.0
Adding requests-oauthlib 1.3.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for importlib-metadata==4.10.0
Best match: importlib-metadata 4.10.0
Adding importlib-metadata 4.10.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for pyasn1-modules==0.2.8
Best match: pyasn1-modules 0.2.8
Adding pyasn1-modules 0.2.8 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for cachetools==4.2.4
Best match: cachetools 4.2.4
Adding cachetools 4.2.4 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for rsa==4.8
Best match: rsa 4.8
Adding rsa 4.8 to easy-install.pth file
Installing pyrsa-decrypt script to /usr/local/bin
Installing pyrsa-encrypt script to /usr/local/bin
Installing pyrsa-keygen script to /usr/local/bin
Installing pyrsa-priv2pub script to /usr/local/bin
Installing pyrsa-sign script to /usr/local/bin
Installing pyrsa-verify script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for fonttools==4.28.5
Best match: fonttools 4.28.5
Adding fonttools 4.28.5 to easy-install.pth file
Installing fonttools script to /usr/local/bin
Installing pyftmerge script to /usr/local/bin
Installing pyftsubset script to /usr/local/bin
Installing ttx script to /usr/local/bin

Using /usr/local/lib/python3.7/site-packages
Searching for kiwisolver==1.3.2
Best match: kiwisolver 1.3.2
Adding kiwisolver 1.3.2 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for pyparsing==3.0.6
Best match: pyparsing 3.0.6
Adding pyparsing 3.0.6 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
```

```

Searching for python-dateutil==2.8.2
Best match: python-dateutil 2.8.2
Adding python-dateutil 2.8.2 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for cycler==0.11.0
Best match: cycler 0.11.0
Adding cycler 0.11.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for oauthlib==3.1.1
Best match: oauthlib 3.1.1
Adding oauthlib 3.1.1 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for zipp==3.6.0
Best match: zipp 3.6.0
Adding zipp 3.6.0 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Searching for pyasn1==0.4.8
Best match: pyasn1 0.4.8
Adding pyasn1 0.4.8 to easy-install.pth file

Using /usr/local/lib/python3.7/site-packages
Finished processing dependencies for realesrgan==0.2.3.0
--2021-12-23 01:46:01-- https://github.com/xinntao/Real-ESRGAN/releases/download/v0.1.0/Realesrgan_x4plus.pth
Resolving github.com (github.com)... 192.30.255.113
Connecting to github.com (github.com)|192.30.255.113|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://objects.githubusercontent.com/github-production-release-asset-2e65be/387326890/08f0e941-ebb7-48f0-9d6a-73e87b710e7e?X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4CSVEH53A%2F20211223%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20211223T014601Z&X-Amz-Expires=300&X-Amz-Signature=ce4c74443740c5ef232b2ac3e90514f7f636c8aaabd099d70a5f4e105efa462d&X-Amz-SignedHeaders=host&actor_id=0&key_id=0&repo_id=387326890&response-content-disposition=attachment%3B%20filename%3DRealesrgan_x4plus.pth&response-content-type=application%2Foctet-stream [following]
--2021-12-23 01:46:01-- https://objects.githubusercontent.com/github-production-release-asset-2e65be/387326890/08f0e941-ebb7-48f0-9d6a-73e87b710e7e?X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4CSVEH53A%2F20211223%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20211223T014601Z&X-Amz-Expires=300&X-Amz-Signature=ce4c74443740c5ef232b2ac3e90514f7f636c8aaabd099d70a5f4e105efa462d&X-Amz-SignedHeaders=host&actor_id=0&key_id=0&repo_id=387326890&response-content-disposition=attachment%3B%20filename%3DRealesrgan_x4plus.pth&response-content-type=application%2Foctet-stream
Resolving objects.githubusercontent.com (objects.githubusercontent.com)... 185.199.108.133, 185.199.109.133, 185.199.110.133, ...
Connecting to objects.githubusercontent.com (objects.githubusercontent.com)|185.199.108.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 67040989 (64M) [application/octet-stream]
Saving to: 'experiments/pretrained_models/Realesrgan_x4plus.pth'

RealESRGAN_x4plus.p 100%[=====>] 63.93M 25.6MB/s in 2.5s

2021-12-23 01:46:04 (25.6 MB/s) - 'experiments/pretrained_models/Realesrgan_x4plus.pth' saved [67040989/67040989]

/content

```

Transfer Learning and Fine Tuning with Real-ESRGAN

using VisDrone Dataset

We provide pretrained models, both our own using transfer learning and the original provided by the researchers behind Real-ESRGAN.

We ran our training model using 10000 iterations and 500 images only. Our intentions to train the model with our original sample size of 6000+ images and all iterations of the original model (1M) gave us an estimated time of completion of 11 days, which was quickly scrapped due to time constraints.

Source: <https://github.com/VisDrone/VisDrone-Dataset>

"Detection and Tracking Meets Drones Challenge"

Journal: "IEEE Transactions on Pattern Analysis and Machine Intelligence"

Authors: Zhu, Pengfei and Wen, Longyin and Du, Dawei and Bian, Xiao and Fan, Heng and Hu, Qinghua and Ling, Haibin.

Year: 2021

DOI: 10.1109/TPAMI.2021.3119563

Select from the dropdown on the right what model of Real-ESRGAN you want to use.

- fitted - A model we trained using transfer learning. Ready to go.
- original - Original model trained by the researchers of Real-ESRGAN

```
In [23]: model_type = "fitted" #@param ["original", "fitted"]
```

```
In [24]: if model_type == 'fitted':
    # Copy Pretrained Model from Drive
    fitted_model_source = 'drive/MyDrive/Data/train_RealesRNetx4plus_1000k_B12G4/m'
    fitted_model_destination = 'Real-ESRGAN/experiments/pretrained_models/RealesRG'
    copyfile(fitted_model_source, fitted_model_destination)
```

2. Enhance CCTV Footage Using Model

Parameters

- --tile (Decreases Memory Consumption by Running the Model on Tiled Versions of the Images)
- --outscale x.x (The scale factor of the model)

```
In [26]: if (dataset == 'video') or (dataset == 'video_demo'):
    original_path = '../original'
elif dataset == 'image':
    original_path = '../drive/MyDrive/Data/train/images'
elif dataset == 'image_small':
    original_path = '../drive/MyDrive/Data/train_small/images'
```

```
else:  
    original_path = '../drive/MyDrive/Data/train_tiny/images'  
  
!rm -rf $enhanced_path  
%cd Real-ESRGAN/  
!python inference_realesrgan.py -n RealESRGAN_x4plus -i $original_path -o $enhanced_path  
%cd ..
```

```
/content/Real-ESRGAN  
Downloading: "https://github.com/xinntao/faceexlib/releases/download/v0.1.0/detection_Resnet50_Final.pth" to /usr/local/lib/python3.7/site-packages/faceexlib/weights/detection_Resnet50_Final.pth  
100% 104M/104M [00:01<00:00, 94.1MB/s]  
Downloading: "https://github.com/TencentARC/GFPGAN/releases/download/v0.2.0/GFPGANCleanv1-NoCE-C2.pth" to /usr/local/lib/python3.7/site-packages/gfpgan/weights/GFPGANCleanv1-NoCE-C2.pth  
100% 332M/332M [00:14<00:00, 23.7MB/s]  
Testing 0 0000036_00500_d_0000046  
    Tile 1/15  
    Tile 2/15  
    Tile 3/15  
    Tile 4/15  
    Tile 5/15  
    Tile 6/15  
    Tile 7/15  
    Tile 8/15  
    Tile 9/15  
    Tile 10/15  
    Tile 11/15  
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Testing 1 0000039_05625_d_0000062  
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Testing 2 0000042_02421_d_0000076  
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Testing 3 0000047_03500_d_0000095
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Testing 4 0000071_02729_d_0000002
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Testing 5 0000071_03470_d_0000005
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Testing 6 0000071_04085_d_0000007
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Testing 7 0000071_07913_d_0000013
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Testing 8 0000076_00352_d_0000002
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Testing 9 0000079_01062_d_0000003
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Testing 10 0000099_04272_d_0000010
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Testing 11 0000102_00919_d_0000023
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Testing 12 0000106_00294_d_0000048
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Testing 13 0000114_00461_d_0000079
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Testing 14 0000123_01819_d_0000120
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Testing 15 0000137_00960_d_0000160
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Testing 16_0000141_00851_d_0000012
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Testing 17 0000142_02658_d_0000036
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Testing 18 0000142_04858_d_0000047
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Testing 19 0000144_00401_d_0000001
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Testing 20 0000165_00525_d_0000086
/usr/local/lib/python3.7/site-packages/torch/nn/functional.py:3680: UserWarning:
The default behavior for interpolate/upsample with float scale_factor changed in
1.6.0 to align with other frameworks/libraries, and now uses scale_factor direct
ly, instead of relying on the computed output size. If you wish to restore the o
ld behavior, please set recompute_scale_factor=True. See the documentation of n
n.Upsample for details.
    "The default behavior for interpolate/upsample with float scale_factor changed
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Testing 21 0000165_02725_d_0000097
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Testing 22 0000165_06125_d_0000114
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Testing 23 0000172_00001_d_0000001
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Testing 24 0000176_00401_d_0000001
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Testing 25 0000179_00445_d_0000016
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Testing 26 0000180_01213_d_0000025
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Testing 27 0000195_01040_d_0000131
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Testing 28 0000197_00401_d_0000147
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Tile 55/60
Tile 56/60
Tile 57/60
Tile 58/60
Tile 59/60
Tile 60/60
Testing 30 0000197_01661_d_0000150
Tile 1/60
Tile 2/60
Tile 3/60
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Tile 59/60
Tile 60/60
Testing 31 0000204_00000_d_0000191
Tile 1/15
Tile 2/15
Tile 3/15
Tile 4/15
Tile 5/15
Tile 6/15
Tile 7/15
Tile 8/15
Tile 9/15
Tile 10/15
Tile 11/15
Tile 12/15
Tile 13/15
Tile 14/15
Tile 15/15
Testing 32 0000205_01665_d_0000200
Tile 1/15
Tile 2/15
Tile 3/15
Tile 4/15
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Tile 6/15
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Tile 12/15
Tile 13/15
Tile 14/15
Tile 15/15
Testing 33 0000209_00296_d_0000220
Tile 1/60
Tile 2/60
Tile 3/60
Tile 4/60
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Tile 58/60
Tile 59/60
Tile 60/60
Testing 34 0000210_01551_d_0000228
Tile 1/60
Tile 2/60
Tile 3/60
Tile 4/60
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Testing 35 0000218_00001_d_0000001
Tile 1/60
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Testing 36 0000220_02658_d_0000008
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Testing 37 0000222_02900_d_0000009
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Testing 38 0000223_00836_d_0000003
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Testing 39 0000225_00001_d_0000001
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Tile 55/60
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Tile 60/60
Testing 40 0000227_00001_d_0000001
Tile 1/60
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Tile 59/60
Tile 60/60
Testing 41 0000236_00811_d_0000003
Tile 1/15
Tile 2/15
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Tile 9/15
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Testing 42 0000239_00708_d_0000003
Tile 1/15
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Tile 4/15
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Tile 7/15
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Testing 43 0000239_02531_d_0000008
Tile 1/15
Tile 2/15
Tile 3/15
Tile 4/15
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Tile 6/15
Tile 7/15
Tile 8/15
Tile 9/15
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Testing 44 0000239_04052_d_0000012
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Tile 14/15
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    Tile 15/15
Testing 45 0000239_05950_d_0000016
    Tile 1/15
    Tile 2/15
    Tile 3/15
    Tile 4/15
    Tile 5/15
    Tile 6/15
    Tile 7/15
    Tile 8/15
    Tile 9/15
    Tile 10/15
    Tile 11/15
    Tile 12/15
    Tile 13/15
    Tile 14/15
    Tile 15/15
Testing 46 0000240_03011_d_0000008
    Tile 1/15
    Tile 2/15
    Tile 3/15
    Tile 4/15
    Tile 5/15
    Tile 6/15
    Tile 7/15
    Tile 8/15
    Tile 9/15
    Tile 10/15
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    Tile 12/15
    Tile 13/15
    Tile 14/15
    Tile 15/15
Testing 47 0000243_01500_d_0000004
    Tile 1/15
    Tile 2/15
    Tile 3/15
    Tile 4/15
    Tile 5/15
    Tile 6/15
    Tile 7/15
    Tile 8/15
    Tile 9/15
    Tile 10/15
    Tile 11/15
    Tile 12/15
    Tile 13/15
    Tile 14/15
    Tile 15/15
Testing 48 0000252_00499_d_0000002
    Tile 1/15
    Tile 2/15
    Tile 3/15
    Tile 4/15
    Tile 5/15
    Tile 6/15
    Tile 7/15
    Tile 8/15
    Tile 9/15
    Tile 10/15
    Tile 11/15
    Tile 12/15
    Tile 13/15
    Tile 14/15
    Tile 15/15
```

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Testing 49 0000256_04356_d_0000036
    Tile 1/28
    Tile 2/28
    Tile 3/28
    Tile 4/28
    Tile 5/28
    Tile 6/28
    Tile 7/28
    Tile 8/28
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    Tile 24/28
    Tile 25/28
    Tile 26/28
    Tile 27/28
    Tile 28/28
/content
```

Examine a Sample of Enhanced Frames

Let's take a look at our now-enhanced footage. We will show a small sample of the total output.

```
In [27]: if (dataset == 'video') or (dataset == 'video_demo'):
    original_path = 'original'
elif dataset == 'image':
    original_path = 'drive/MyDrive/Data/train/images'
elif dataset == 'image_small':
    original_path = 'drive/MyDrive/Data/train_small/images'
else:
    original_path = 'drive/MyDrive/Data/train_tiny/images'

enhanced_path = 'enhanced'
input_list = sorted(glob.glob(os.path.join(original_path, '*')))
output_list = sorted(glob.glob(os.path.join(enhanced_path, '*')))
frames_to_process = len(input_list)

path = zip(input_list, output_list)
path_list = list(path)
frames = random.sample(path_list, 5)
for path in frames:
    img_input = imread(path[0])
    img_output = imread(path[1])
    frame_selected = path[0][9:-4].strip("0")
    print(f'Frame or Image {frame_selected}/{frames_to_process}')
    display_image([img_input, img_output], ["Original", "GFPGAN Enhanced"])
```

```
Frame or Image rive/Data/train_tiny/images/0000165_06125_d_0000114/50
```



Frame or Image rive/Data/train_tiny/images/0000195_01040_d_0000131/50
Original



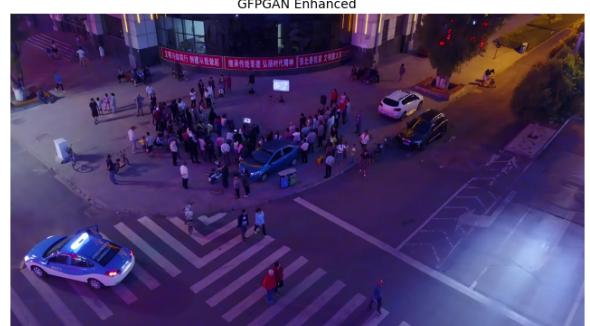
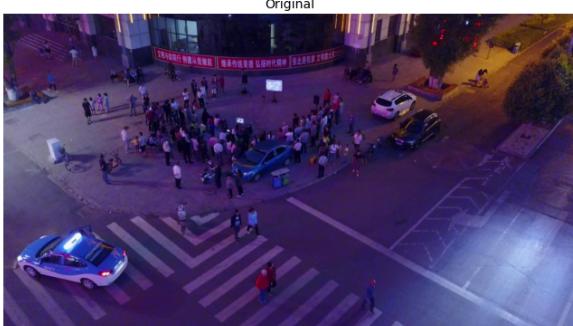
Frame or Image rive/Data/train_tiny/images/0000243_01500_d_0000004/50
Original



Frame or Image rive/Data/train_tiny/images/0000197_00851_d_0000148/50
Original



Frame or Image rive/Data/train_tiny/images/0000071_04085_d_0000007/50
Original



As we can see, the enhanced frames are much smoother and visually sharper than the original frames from the raw footage. But how will this affect object detection predictions? Will it improve the scoring of objects now that there's more visual clarity in the images? Or will they perform worse than the original, low-resolution footage?

3. Compare confidence scores in *original images* vs. *enhanced images*

To find out, we compare the results after feeding both the *original* frames as well as the *enhanced* frames through *inception_resnet_v2*.

In [28]:

```
input_list = sorted(glob.glob(os.path.join(original_path, '*')))
output_list = sorted(glob.glob(os.path.join(enhanced_path, '*')))

data = []
frame_num = 1

for original_image_path, enhanced_image_path in zip(input_list, output_list):
    print(f'Frame or Image {frame_num}/{len(frames_to_process)}')
    print('=====')
    print(original_image_path)
    print(enhanced_image_path)
    _data = run_detector([original_image_path, enhanced_image_path], ['Original'])
    data.append(_data)
    frame_num = frame_num + 1
```

Frame or Image 1/50

=====

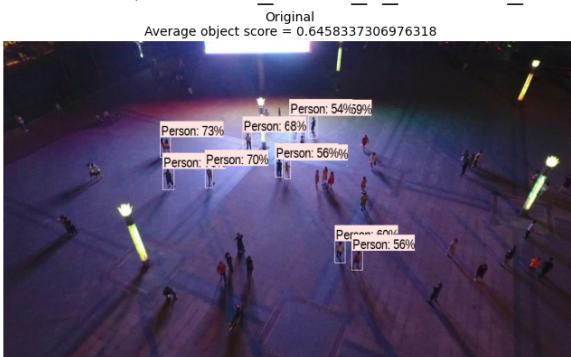
drive/MyDrive/Data/train_tiny/images/0000036_00500_d_0000046.jpg
 enhanced/0000036_00500_d_0000046_out.jpg



Frame or Image 2/50

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drive/MyDrive/Data/train_tiny/images/0000039_05625_d_0000062.jpg
 enhanced/0000039_05625_d_0000062_out.jpg



Frame or Image 3/50

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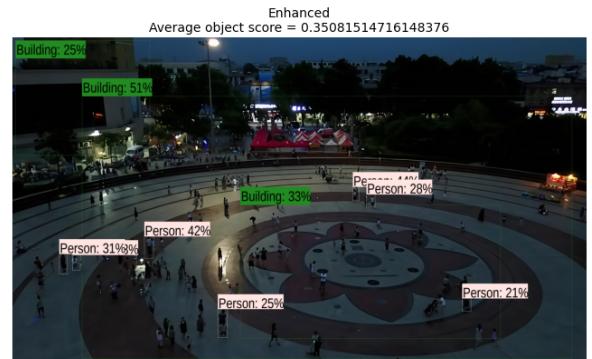
drive/MyDrive/Data/train_tiny/images/0000042_02421_d_0000076.jpg
enhanced/0000042_02421_d_0000076_out.jpg



Frame or Image 4/50

=====

drive/MyDrive/Data/train_tiny/images/0000047_03500_d_0000095.jpg
enhanced/0000047_03500_d_0000095_out.jpg



Frame or Image 5/50

=====

drive/MyDrive/Data/train_tiny/images/0000071_02729_d_0000002.jpg
enhanced/0000071_02729_d_0000002_out.jpg



Frame or Image 6/50

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drive/MyDrive/Data/train_tiny/images/0000071_03470_d_0000005.jpg
enhanced/0000071_03470_d_0000005_out.jpg



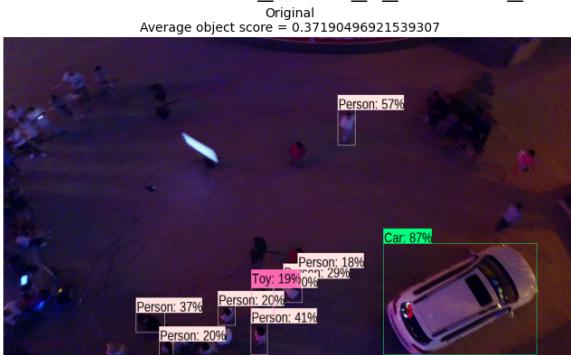
Frame or Image 7/50

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=====
drive/MyDrive/Data/train_tiny/images/0000071_04085_d_0000007.jpg
enhanced/0000071_04085_d_0000007_out.jpg
```



Frame or Image 8/50

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=====
drive/MyDrive/Data/train_tiny/images/0000071_07913_d_0000013.jpg
enhanced/0000071_07913_d_0000013_out.jpg
```



Frame or Image 9/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000076_00352_d_0000002.jpg
enhanced/0000076_00352_d_0000002_out.jpg
```



Frame or Image 10/50

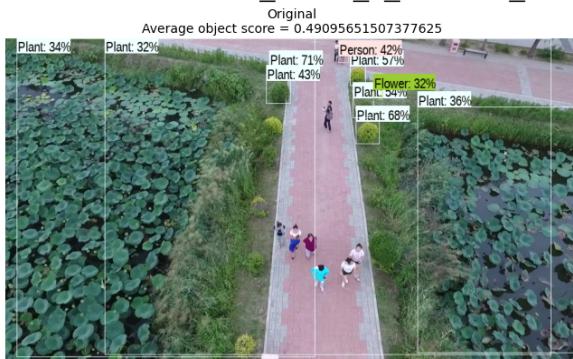
drive/MyDrive/Data/train_tiny/images/0000079_01062_d_0000003.jpg
enhanced/0000079_01062_d_0000003_out.jpg



Frame or Image 11/50

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drive/MyDrive/Data/train_tiny/images/0000099_04272_d_0000010.jpg
enhanced/0000099_04272_d_0000010_out.jpg



Frame or Image 12/50

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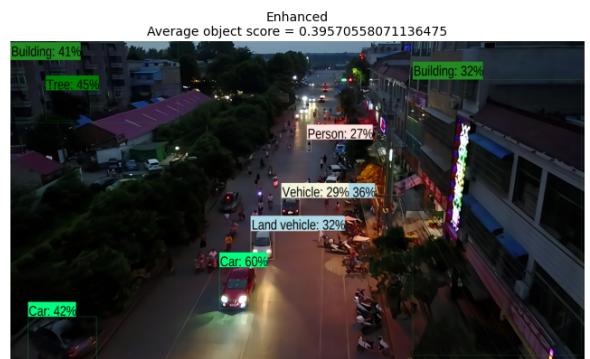
drive/MyDrive/Data/train_tiny/images/0000102_00919_d_0000023.jpg
enhanced/0000102_00919_d_0000023_out.jpg



Frame or Image 13/50

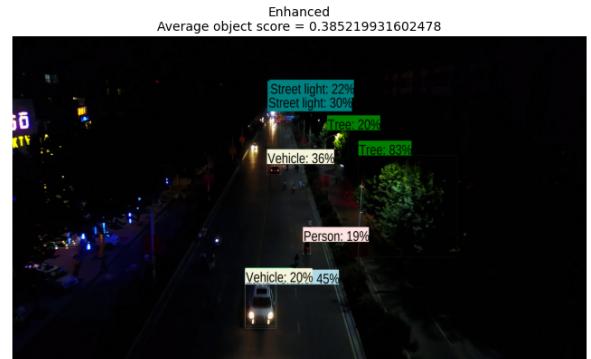
=====

drive/MyDrive/Data/train_tiny/images/0000106_00294_d_0000048.jpg
enhanced/0000106_00294_d_0000048_out.jpg



Frame or Image 14/50

=====
drive/MyDrive/Data/train_tiny/images/0000114_00461_d_0000079.jpg
enhanced/0000114_00461_d_0000079_out.jpg



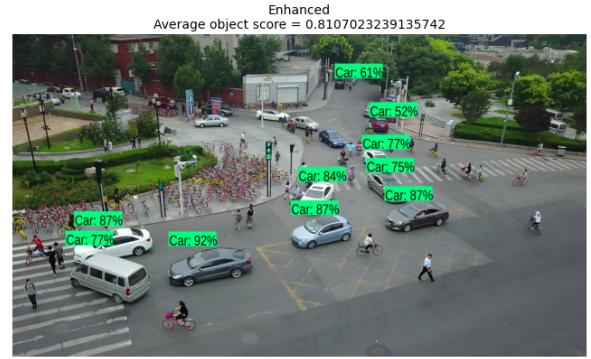
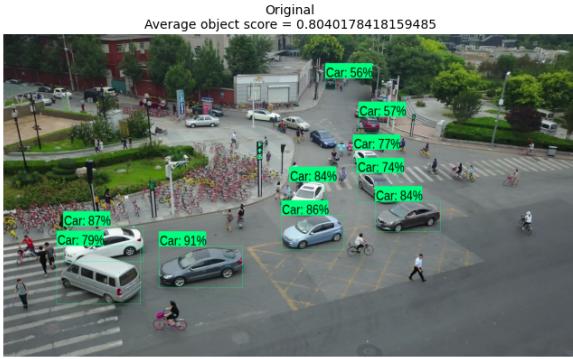
Frame or Image 15/50

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drive/MyDrive/Data/train_tiny/images/0000123_01819_d_0000120.jpg
enhanced/0000123_01819_d_0000120_out.jpg



Frame or Image 16/50

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drive/MyDrive/Data/train_tiny/images/0000137_00960_d_0000160.jpg
enhanced/0000137_00960_d_0000160_out.jpg



Frame or Image 17/50

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drive/MyDrive/Data/train_tiny/images/0000141_00851_d_0000012.jpg
enhanced/0000141_00851_d_0000012_out.jpg



Frame or Image 18/50

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drive/MyDrive/Data/train_tiny/images/0000142_02658_d_0000036.jpg
enhanced/0000142_02658_d_0000036_out.jpg



Frame or Image 19/50

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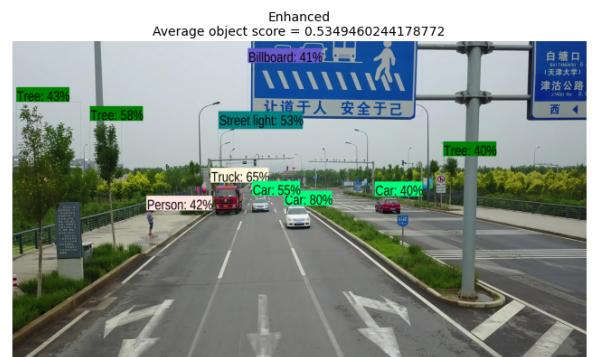
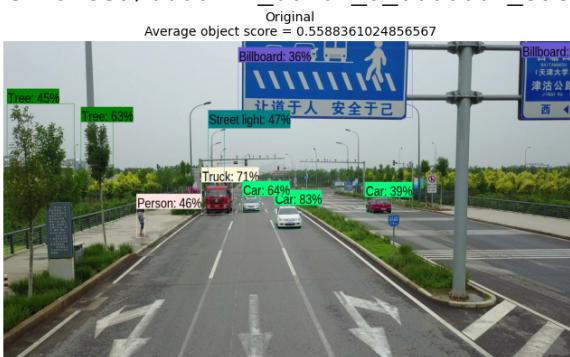
drive/MyDrive/Data/train_tiny/images/0000142_04858_d_0000047.jpg
enhanced/0000142_04858_d_0000047_out.jpg



Frame or Image 20/50

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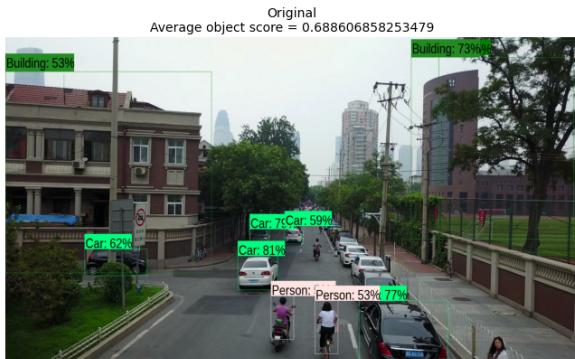
drive/MyDrive/Data/train_tiny/images/0000144_00401_d_0000001.jpg
enhanced/0000144_00401_d_0000001_out.jpg



Frame or Image 21/50

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drive/MyDrive/Data/train_tiny/images/0000165_00525_d_0000086.jpg
enhanced/0000165_00525_d_0000086_out.jpg



Frame or Image 22/50

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drive/MyDrive/Data/train_tiny/images/0000165_02725_d_0000097.jpg
enhanced/0000165_02725_d_0000097_out.jpg
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Frame or Image 23/50

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drive/MyDrive/Data/train_tiny/images/0000165_06125_d_0000114.jpg
enhanced/0000165_06125_d_0000114_out.jpg
```



Frame or Image 24/50

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drive/MyDrive/Data/train_tiny/images/0000172_00001_d_0000001.jpg
enhanced/0000172_00001_d_0000001_out.jpg
```



Frame or Image 25/50

drive/MyDrive/Data/train_tiny/images/0000176_00401_d_0000001.jpg
enhanced/0000176_00401_d_0000001_out.jpg



Frame or Image 26/50

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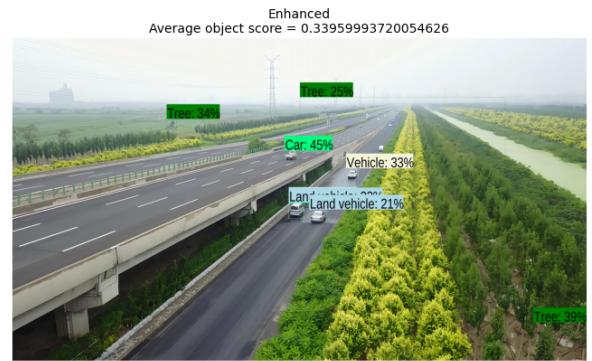
drive/MyDrive/Data/train_tiny/images/0000179_00445_d_0000016.jpg
enhanced/0000179_00445_d_0000016_out.jpg



Frame or Image 27/50

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drive/MyDrive/Data/train_tiny/images/0000180_01213_d_0000025.jpg
enhanced/0000180_01213_d_0000025_out.jpg



Frame or Image 28/50

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drive/MyDrive/Data/train_tiny/images/0000195_01040_d_0000131.jpg
enhanced/0000195_01040_d_0000131_out.jpg



Frame or Image 29/50

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drive/MyDrive/Data/train_tiny/images/0000197_00401_d_0000147.jpg
enhanced/0000197_00401_d_0000147_out.jpg



Frame or Image 30/50

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drive/MyDrive/Data/train_tiny/images/0000197_00851_d_0000148.jpg
enhanced/0000197_00851_d_0000148_out.jpg



Frame or Image 31/50

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drive/MyDrive/Data/train_tiny/images/0000197_01661_d_0000150.jpg
enhanced/0000197_01661_d_0000150_out.jpg



Frame or Image 32/50

=====

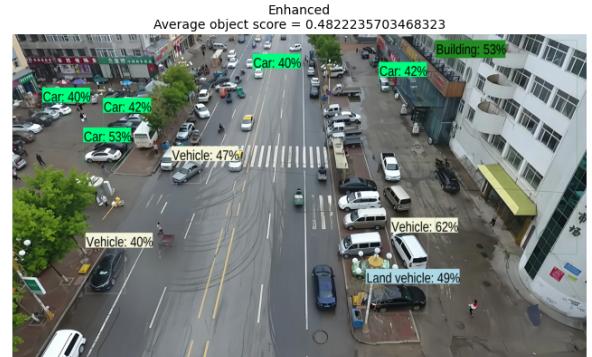
drive/MyDrive/Data/train_tiny/images/0000204_00000_d_0000191.jpg
enhanced/0000204_00000_d_0000191_out.jpg



Frame or Image 33/50

=====

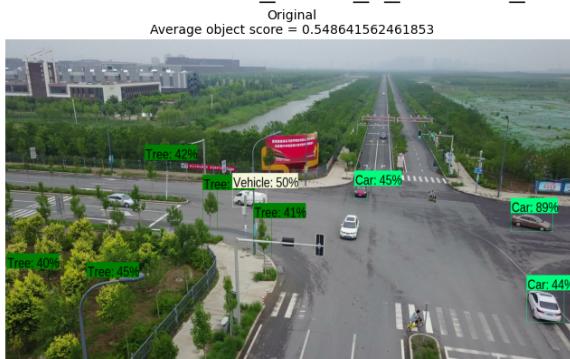
drive/MyDrive/Data/train_tiny/images/0000205_01665_d_0000200.jpg
enhanced/0000205_01665_d_0000200_out.jpg



Frame or Image 34/50

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drive/MyDrive/Data/train_tiny/images/0000209_00296_d_0000220.jpg
enhanced/0000209_00296_d_0000220_out.jpg



Frame or Image 35/50

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drive/MyDrive/Data/train_tiny/images/0000210_01551_d_0000228.jpg
enhanced/0000210_01551_d_0000228_out.jpg



Frame or Image 36/50

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drive/MyDrive/Data/train_tiny/images/0000218_00001_d_0000001.jpg
enhanced/0000218_00001_d_0000001_out.jpg



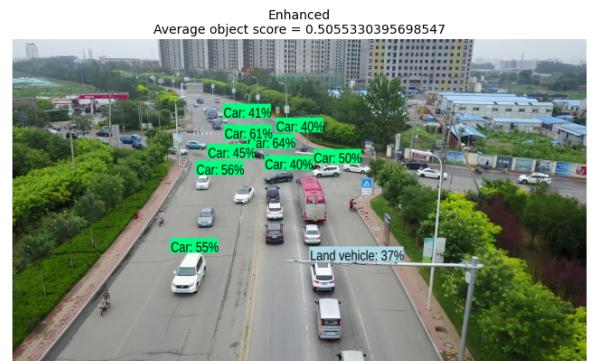
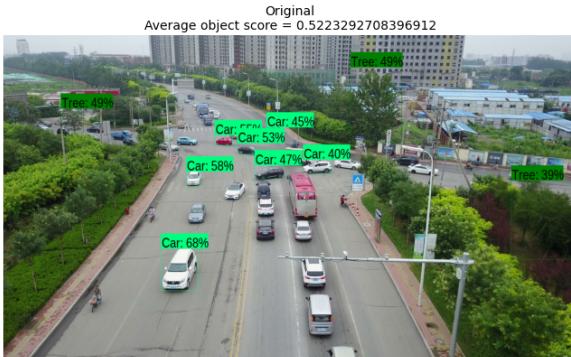
Frame or Image 37/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000220_02658_d_0000008.jpg
enhanced/0000220_02658_d_0000008_out.jpg
```



Frame or Image 38/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000222_02900_d_0000009.jpg
enhanced/0000222_02900_d_0000009_out.jpg
```



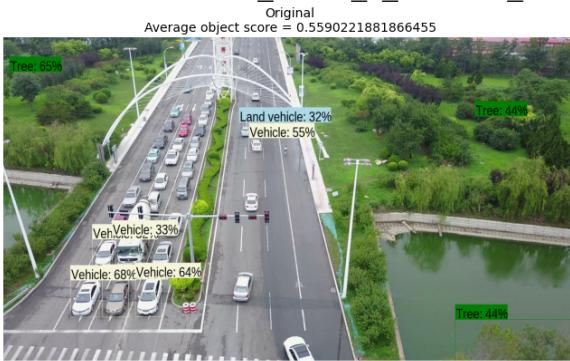
Frame or Image 39/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000223_00836_d_0000003.jpg
enhanced/0000223_00836_d_0000003_out.jpg
```



Frame or Image 40/50

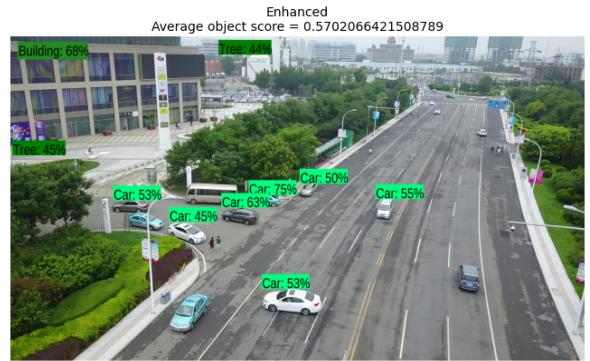
drive/MyDrive/Data/train_tiny/images/0000225_00001_d_0000001.jpg
enhanced/0000225_00001_d_0000001_out.jpg



Frame or Image 41/50

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drive/MyDrive/Data/train_tiny/images/0000227_00001_d_0000001.jpg
enhanced/0000227_00001_d_0000001_out.jpg



Frame or Image 42/50

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drive/MyDrive/Data/train_tiny/images/0000236_00811_d_0000003.jpg
enhanced/0000236_00811_d_0000003_out.jpg



Frame or Image 43/50

=====

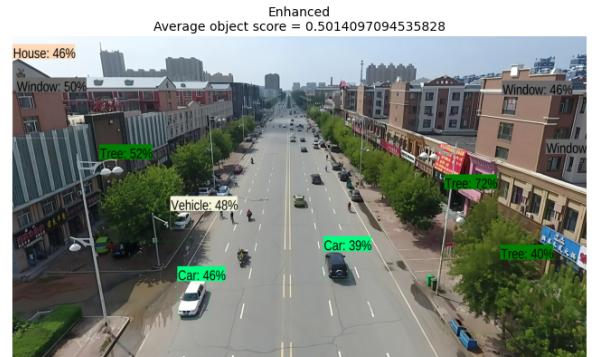
drive/MyDrive/Data/train_tiny/images/0000239_00708_d_0000003.jpg
enhanced/0000239_00708_d_0000003_out.jpg



Frame or Image 44/50

=====

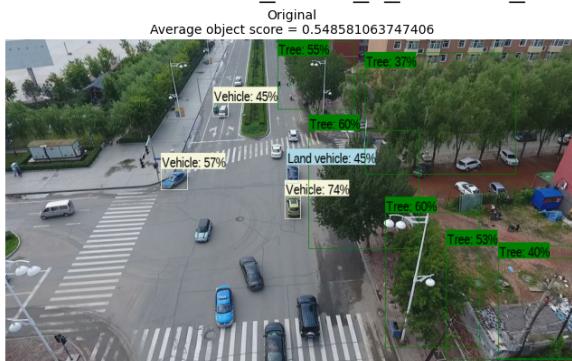
drive/MyDrive/Data/train_tiny/images/0000239_02531_d_0000008.jpg
enhanced/0000239_02531_d_0000008_out.jpg



Frame or Image 45/50

=====

drive/MyDrive/Data/train_tiny/images/0000239_04052_d_0000012.jpg
enhanced/0000239_04052_d_0000012_out.jpg



Frame or Image 46/50

=====

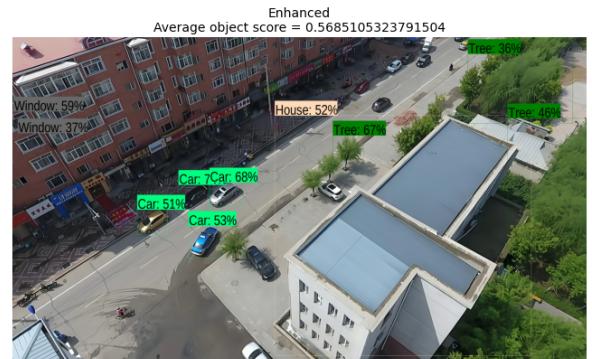
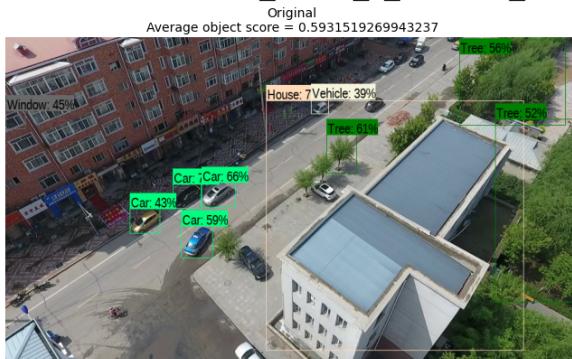
drive/MyDrive/Data/train_tiny/images/0000239_05950_d_0000016.jpg
enhanced/0000239_05950_d_0000016_out.jpg



Frame or Image 47/50

=====

drive/MyDrive/Data/train_tiny/images/0000240_03011_d_0000008.jpg
enhanced/0000240_03011_d_0000008_out.jpg



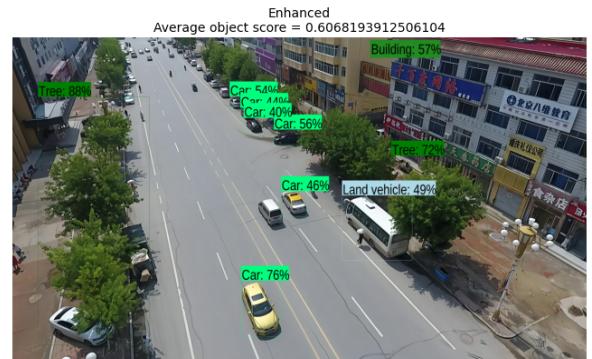
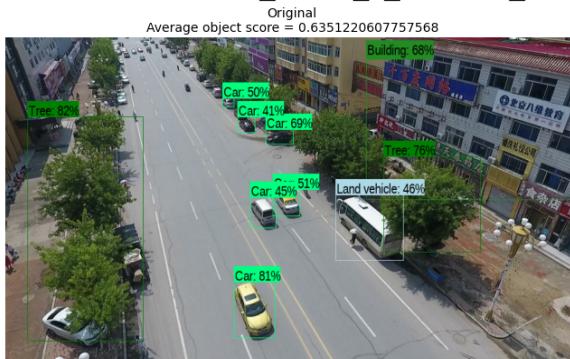
Frame or Image 48/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000243_01500_d_0000004.jpg
enhanced/0000243_01500_d_0000004_out.jpg
```



Frame or Image 49/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000252_00499_d_0000002.jpg
enhanced/0000252_00499_d_0000002_out.jpg
```



Frame or Image 50/50

```
=====
drive/MyDrive/Data/train_tiny/images/0000256_04356_d_0000036.jpg
enhanced/0000256_04356_d_0000036_out.jpg
```



Running Real-ESRGAN Enhanced Images through RCNN Mask

In [29]:

```
enhanced_path = 'enhanced'
enhanced_list = sorted(glob.glob(os.path.join(enhanced_path, '*')))
frames_to_process = len(enhanced_list)
masked_data = []

for frame_num, enhanced_image_path in enumerate(enhanced_list):
    enhanced_output = 'masked/enhanced/' + enhanced_image_path[9:]
    print(f'Processing Frame or Image: {frame_num + 1}/{frames_to_process}')

    img_enhanced = imread(enhanced_image_path)
```

```
enhanced_result = inference_detector(model, img_enhanced)
model.show_result(img_enhanced, enhanced_result, out_file=enhanced_output)
```

```
Processing Frame or Image: 1/50
Processing Frame or Image: 2/50
Processing Frame or Image: 3/50
Processing Frame or Image: 4/50
Processing Frame or Image: 5/50
Processing Frame or Image: 6/50
Processing Frame or Image: 7/50
Processing Frame or Image: 8/50
Processing Frame or Image: 9/50
Processing Frame or Image: 10/50
Processing Frame or Image: 11/50
Processing Frame or Image: 12/50
Processing Frame or Image: 13/50
Processing Frame or Image: 14/50
Processing Frame or Image: 15/50
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Processing Frame or Image: 40/50
Processing Frame or Image: 41/50
Processing Frame or Image: 42/50
Processing Frame or Image: 43/50
Processing Frame or Image: 44/50
Processing Frame or Image: 45/50
Processing Frame or Image: 46/50
Processing Frame or Image: 47/50
Processing Frame or Image: 48/50
Processing Frame or Image: 49/50
Processing Frame or Image: 50/50
```

Displaying a Small Subset of Results Comparing Original Images Masked and Enhanced Images
Masked

In [30]:

```
original_masked_path = 'masked/original'
enhanced_masked_path = 'masked/enhanced'
original_masked_list = sorted(glob.glob(os.path.join(original_masked_path, '*')))
enhanced_masked_list = sorted(glob.glob(os.path.join(enhanced_masked_path, '*')))

frame_num = 1
```

```

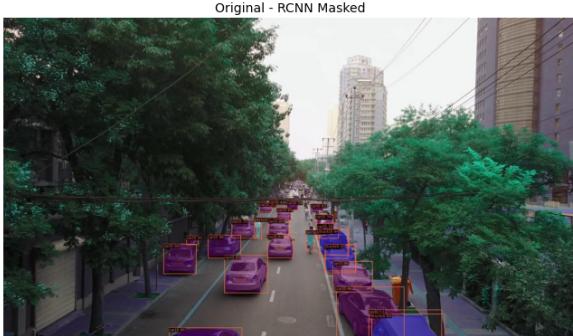
path = zip(original_masked_list, enhanced_masked_list)
path_list = list(path)
frames = random.sample(path_list, 5)
for path in frames:
    root_path_length = len(original_masked_path) + 1
    img_input = imread(path[0])
    img_output = imread(path[1])
    frame_selected = path[0][root_path_length:-4].strip("0")
    print(f'Frame or Image {frame_selected}/{len(original_masked_list)}')
    display_image([img_input, img_output], ["Original - RCNN Masked", "GFGAN Enhanced"])
    frame_num = frame_num + 1

```

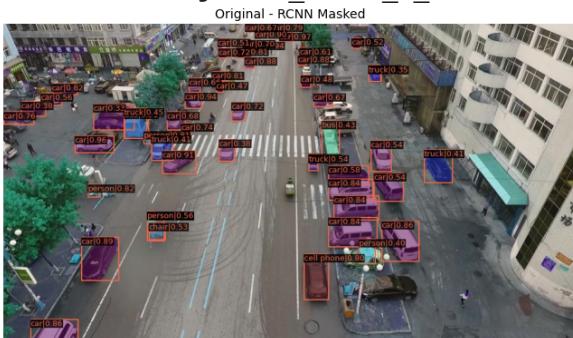
Frame or Image 197_00851_d_0000148/50



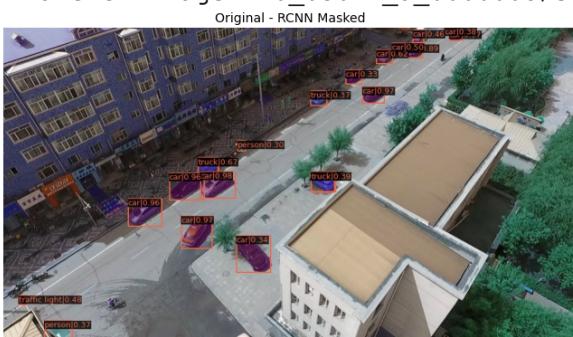
Frame or Image 165_02725_d_0000097/50



Frame or Image 205_01665_d_00002/50



Frame or Image 240_03011_d_0000008/50



Frame or Image 141_00851_d_0000012/50

Original - RCNN Masked



GFPGAN Enhanced - RCNN Masked



Although we can visually see that not all of the enhanced frames have higher scores, let's measure and plot our results to see a more comprehensive visualization of our findings, across the entirety of the footage.

In [31]:

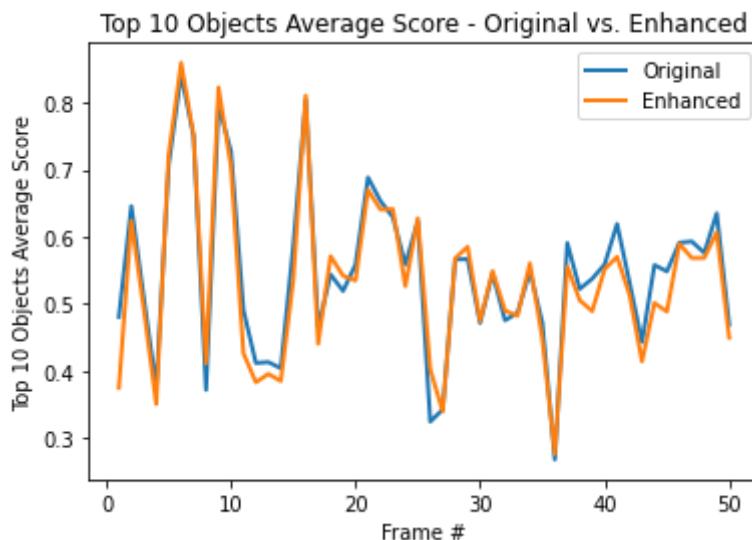
```
# Calculate and plot the total average scores of the top 10 objects
# across the original footage and the enhanced footage (ie: across all frames)
original_top_10_scores = []
enhanced_top_10_scores = []
original_averages = []
enhanced_averages = []

# Get each frames average top 10 objects score
for i in range(len(data)):
    score = [sub['top_10_scores'] for sub in data[i] if sub.get('original') == True]
    original_top_10_scores.append(score)
for i in range(len(data)):
    score = [sub['top_10_scores'] for sub in data[i] if sub.get('original') == False]
    enhanced_top_10_scores.append(score)

# Average score for the top 10 objects in each frame
for i, j in enumerate(original_top_10_scores):
    original_averages.append(np.mean(j))
for i, j in enumerate(enhanced_top_10_scores):
    enhanced_averages.append(np.mean(j))

# Plot avg score for top 10 objects in each original frame vs. enhanced frame
plt.plot(range(1,len(original_top_10_scores)+1), original_averages, lw=2)
plt.plot(range(1,len(enhanced_top_10_scores)+1), enhanced_averages, lw=2)
plt.legend(['Original', 'Enhanced'])
plt.title('Top 10 Objects Average Score - Original vs. Enhanced')
plt.xlabel('Frame #')
plt.ylabel('Top 10 Objects Average Score')
plt.show()

print(f'Top 10 objects average score')
print('=====')
print(f'Original = {np.mean(original_averages)}')
print(f'Enhanced = {np.mean(enhanced_averages)}')
```



```
Top 10 objects average score
=====
Original = 0.5480654835700989
Enhanced = 0.5359372496604919
```

Transform Modified Frames back into Video Format

```
In [32]: from google.colab.patches import cv2_imshow
```

```
In [34]: def generate_video(input_path='original_objects', output_path='videos/output.mp4'):
    frames = []
    FPS = 25.0

    frames_list = sorted(glob.glob(os.path.join(input_path, '*')))

    for path in frames_list:
        root_path_length = len(original_masked_path) + 1
        img_input = imread(path)
        height, width, layers = img_input.shape
        img_size = (width, height)
        frames.append(img_input)

    out = cv2.VideoWriter(output_path, cv2.VideoWriter_fourcc(*'DIVX'), FPS, img_size)
    for index in range(len(frames)):
        out.write(frames[index])
    out.release()
    return img_size

if (dataset == 'video') or (dataset == 'video_demo'):
    video_size = generate_video('masked/enhanced')
    print("Video generation done, please download it from the 'videos' folder.")
```