

PRE-FINAL REVIEW

VIDEO ANALYTICS THROUGH DEEP LEARNING IN THE FIELD OF ATHLETE SPORTS

DATE: 28/04/2023



OBJECTIVE OF THE PROJECT

- To Enhance and Augment the Gameplay & Training sessions of the respective field of Sport.
- To build an advanced sports analytical system that opens up another Perspective over the Game; taking Players involved, Placements & Strategies into consideration.

EXISTING SYSTEM

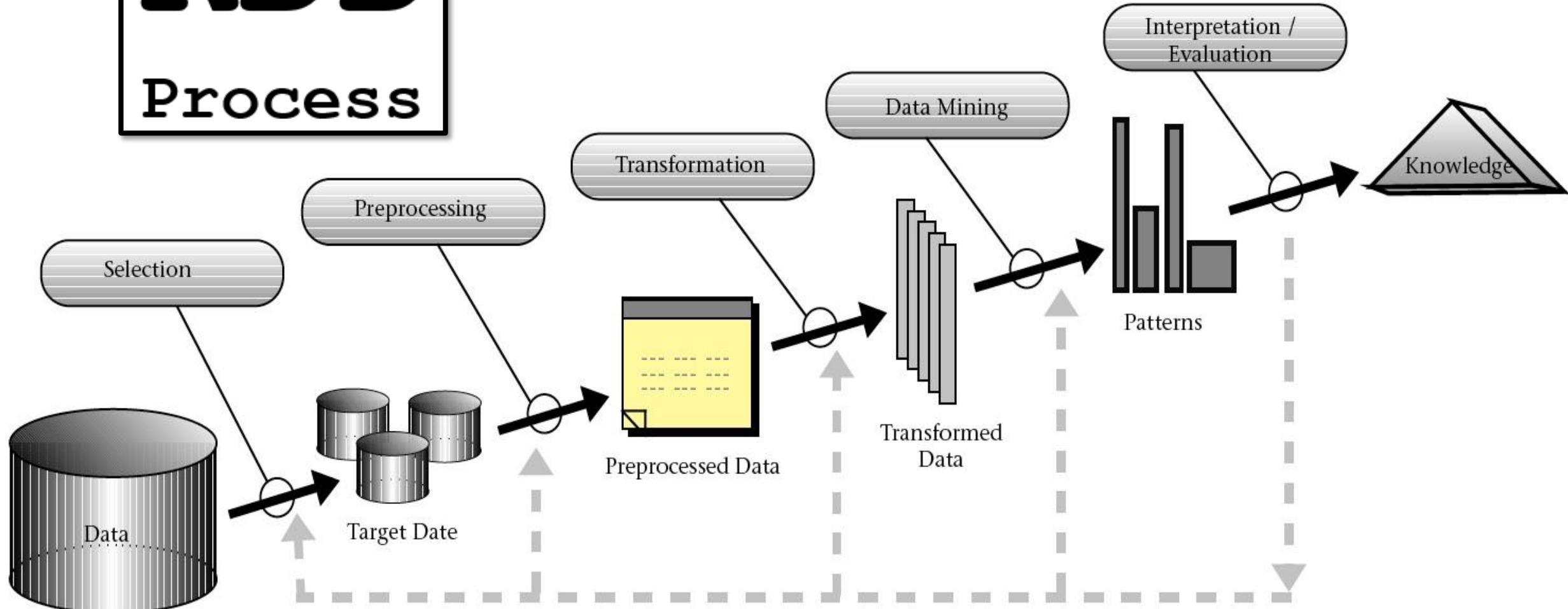
Analysis is outrightly, performed by humans, putting meticulous work & focus; That might also open up a Huge margin for Negligence & Error.

DRAWBACKS

- Human Negligence
- Time Consuming.
- Requires Meticulous Work

KDD

Process



Windows PowerShell

Command Prompt

- X

X

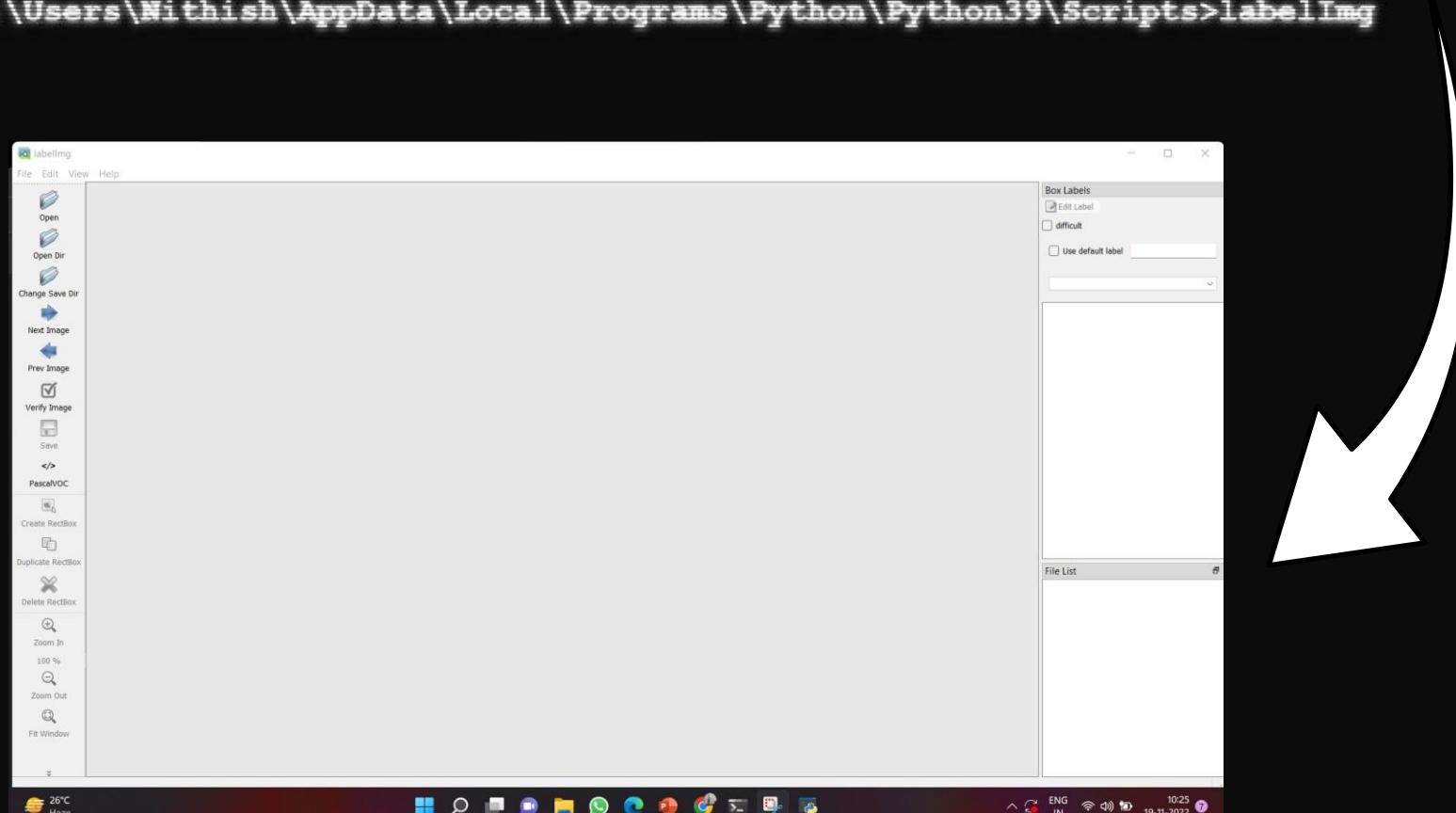
i Windows Terminal can be set as the default terminal application in your settings. Open Settings

Microsoft Windows [Version 10.0.22000.856]

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C:\Users\Nithish>cd C:\Users\Nithish\AppData\Local\Programs\Python\Python39\Scripts

C:\Users\Nithish\AppData\Local\Programs\Python\Python39\Scripts>labelImg





Box Labels

 Edit Label

- difficult
- Use default label

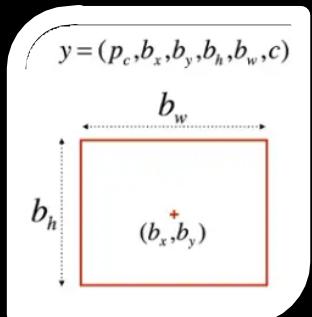
- ✓ player
 - ✓ player
 - ✓ face
 - ✓ face
 - ✓ player
 - ✓ basket
 - ✓ b_ball
 - ✓ player
 - ✓ face
 - ✓ player
 - ✓ player
 - ✓ player

File List

```

1 <annotation verified="yes">
2   <folder>DataSet</folder>
3   <filename>0.png</filename>
4   <path>C:\PSG\3rd Year\V SEM\Project\Data Collection\DataSet\0.png</path>
5   <source>
6     <database>Unknown</database>
7   </source>
8   <size>
9     <width>500</width>
10    <height>500</height>
11    <depth>3</depth>
12  </size>
13  <segmented>0</segmented>
14  <object>
15    <name>b_ball</name>
16    <pose>Unspecified</pose>
17    <truncated>0</truncated>
18    <difficult>0</difficult>
19    <bndbox>
20      <xmin>288</xmin>
21      <ymin>20</ymin>
22      <xmax>352</xmax>
23      <ymax>77</ymax>
24    </bndbox>
25  </object>
26  <object>
27    <name>player</name>
28    <pose>Unspecified</pose>
29    <truncated>0</truncated>
30    <difficult>0</difficult>
31    <bndbox>
32      <xmin>150</xmin>
33      <ymin>51</ymin>
34      <xmax>356</xmax>
35      <ymax>490</ymax>
36    </bndbox>
37  </object>

```



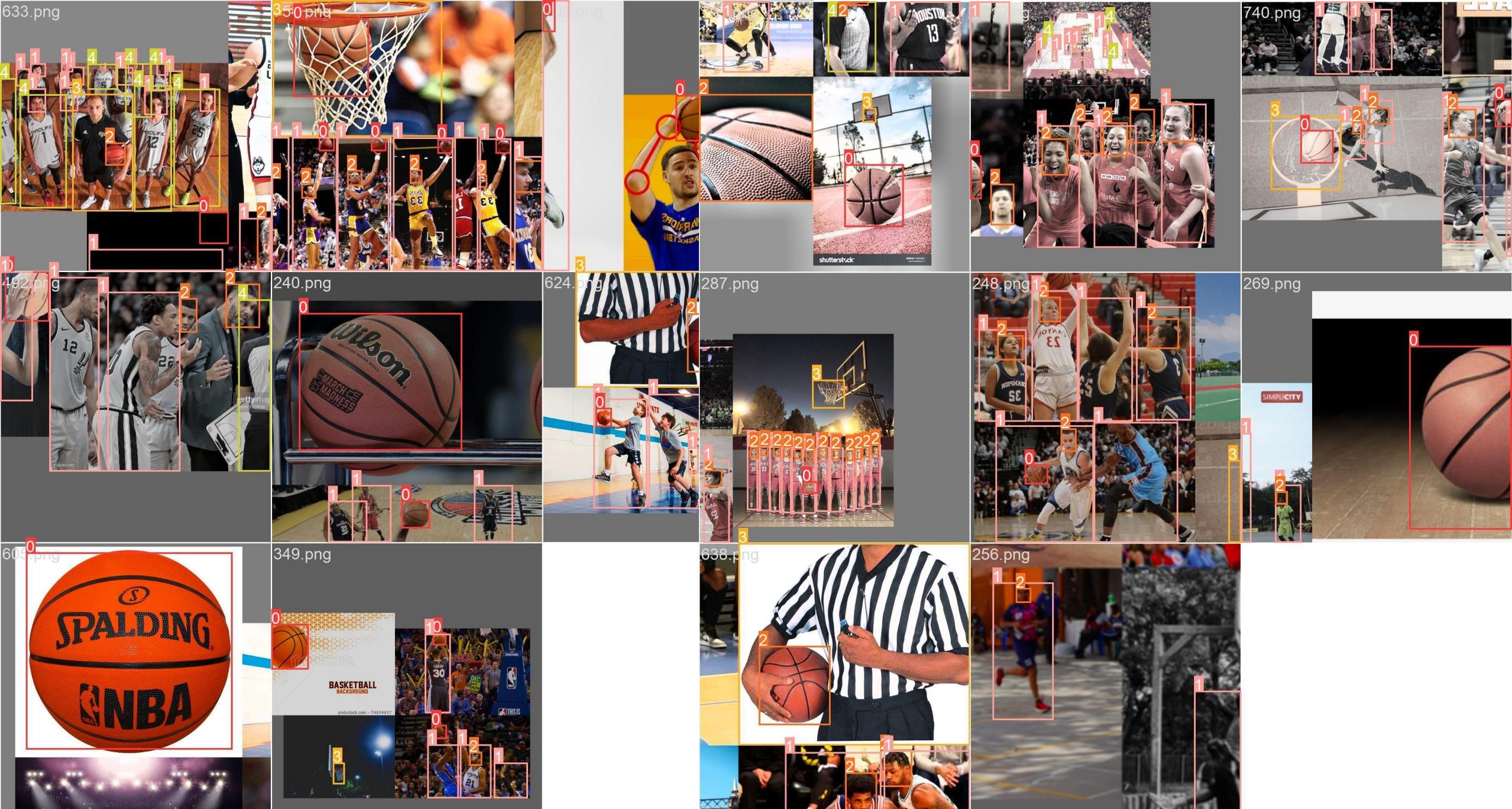
	704.txt	faster_rcnn_resnet152_v1_1024x1024_coco17_tpu-8.config	pipeline.config	compare-train.ipynb	pipeline (1).config
	Class	X_centre	Y_centre	Width	Height
0	0	0.739746	0.785933	0.303711	0.388379
3	3	0.678223	0.360092	0.504883	0.701835

```

x_centre = (xmin + ((xmax - xmin) / 2)) / img_width
y_centre = (ymin + ((ymax - ymin) / 2)) / img_height
h = (ymax - ymin) / img_height
w = (xmax - xmin) / img_width

```

Class_Name	Class_id
b_ball	0
player	1
face	2
basket	3
referee	4



This PC > Base Disk (K:) > Python Files > VideoAnalytics > CompleteDataset



Data



test



train

20 : 80 Ratio

Data Transformation

This PC > Base Disk (K:) > Python Files > VideoAnalytics



Search VideoAnalytics



CompleteDataset



test_labels



train_labels



csv_to_record



train



xml_to_csv



test_labels.record

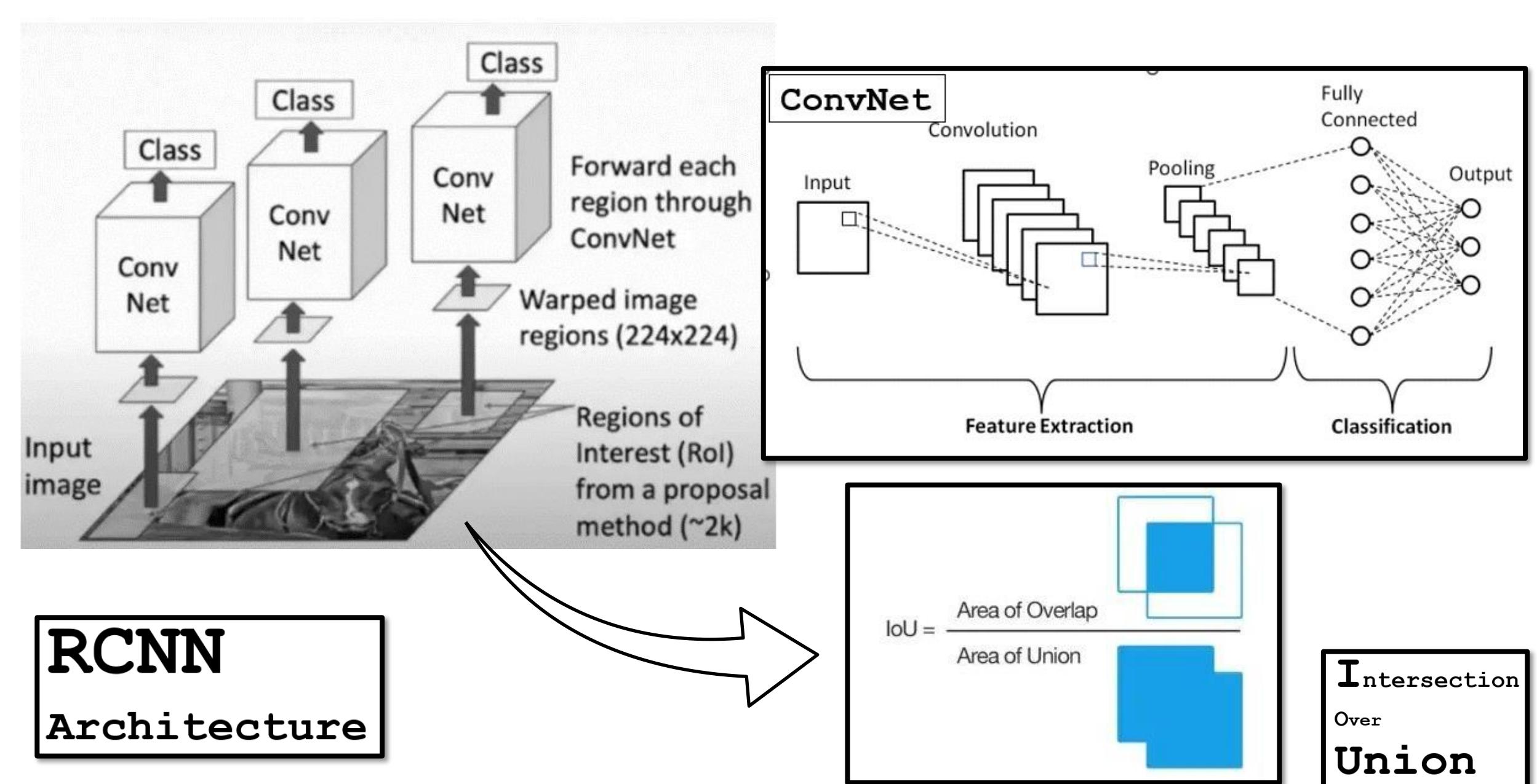


train_labels.record



csv_to_record

A	B	C	D	E	F	G	H
1	filename	width	height	class	xmin	ymin	ymax
2	0.png	500	500	b_ball	288	20	352
3	0.png	500	500	player	150	51	356
4	0.png	500	500	face	226	114	282
5	1.png	1000	667	b_ball	419	90	473
6	1.png	1000	667	basket	266	86	368
7	1.png	1000	667	player	373	140	467
8	1.png	1000	667	player	549	190	770
9	1.png	1000	667	face	935	214	1000
10	1.png	1000	667	face	402	213	437
11	1.png	1000	667	face	339	264	374
12	1.png	1000	667	player	302	261	389
13	1.png	1000	667	player	435	141	582
14	1.png	1000	667	player	883	202	1000



SSD ResNet101 V1 FPN 1024x1024 (RetinaNet101)	104	39.5	Boxes
SSD ResNet152 V1 FPN 640x640 (RetinaNet152)	80	35.4	Boxes
SSD ResNet152 V1 FPN 1024x1024 (RetinaNet152)	111	39.6	Boxes
Faster R-CNN ResNet50 V1 640x640	53	29.3	Boxes
Faster R-CNN ResNet50 V1 1024x1024	65	31.0	Boxes
Faster R-CNN ResNet50 V1 800x1333	65	31.6	Boxes
Faster R-CNN ResNet101 V1 640x640	55	31.8	Boxes
Faster R-CNN ResNet101 V1 1024x1024	72	37.1	Boxes
Faster R-CNN ResNet101 V1 800x1333	77	36.6	Boxes
Faster R-CNN ResNet152 V1 640x640	64	32.4	Boxes
Faster R-CNN ResNet152 V1 1024x1024	85	37.6	Boxes
Faster R-CNN ResNet152 V1 800x1333	101	37.4	Boxes
Faster R-CNN Inception ResNet V2 640x640	206	37.7	Boxes
Faster R-CNN Inception ResNet V2 1024x1024	236	38.7	Boxes
Mask R-CNN Inception ResNet V2 1024x1024	301	39.0/34.6	Boxes/Masks
ExtremeNet (deprecated)	--	--	Boxes
ExtremeNet	--	--	Boxes

TensorFlow2 ZOO Models Repository

+ Code + Text

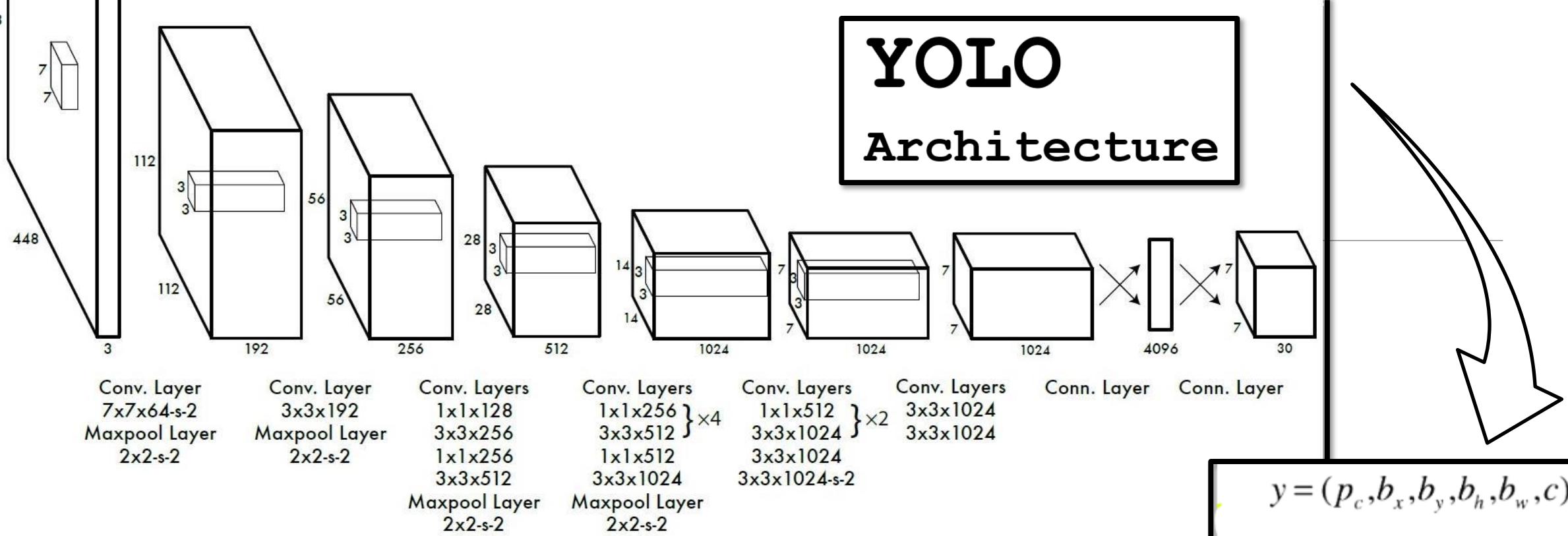
RAM Disk Editing

```
!python model_main_tf2.py --pipeline_config_path=/content/gdrive/MyDrive/VideoAnalyticsProjectStuff/Dataset/faster_rcnn_resnet152_v1_1024x1024_coco17_tpu-8.config --model_dir=/mydrive/VideoAn  
2022-12-08 06:13:44.835981: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU  
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.  
/usr/local/lib/python3.8/dist-packages/tensorflow_addons/utils/ensure_tf_install.py:53: UserWarning: Tensorflow Addons supports using Python ops for all Tensorflow versions above or equal to  
The versions of TensorFlow you are currently using is 2.11.0 and is not supported.  
Some things might work, some things might not.  
If you were to encounter a bug, do not file an issue.  
If you want to make sure you're using a tested and supported configuration, either change the TensorFlow version or the TensorFlow Addons's version.  
You can find the compatibility matrix in TensorFlow Addon's readme:  
https://github.com/tensorflow/addons  
    warnings.warn(  
WARNING:tensorflow:There are non-GPU devices in `tf.distribute.Strategy`, not using nccl allreduce.  
W1208 06:13:49.431892 139860059768704 cross_device_ops.py:1387] There are non-GPU devices in `tf.distribute.Strategy`, not using nccl allreduce.  
INFO:tensorflow:Using MirroredStrategy with devices ('/job:localhost/replica:0/task:0/device:CPU:0',)  
I1208 06:13:49.453435 139860059768704 mirrored_strategy.py:374] Using MirroredStrategy with devices ('/job:localhost/replica:0/task:0/device:CPU:0',)  
INFO:tensorflow:Maybe overwriting train_steps: None  
I1208 06:13:49.461396 139860059768704 config_util.py:552] Maybe overwriting train_steps: None  
INFO:tensorflow:Maybe overwriting use_bfloat16: False  
I1208 06:13:49.461648 139860059768704 config_util.py:552] Maybe overwriting use_bfloat16: False  
WARNING:tensorflow:From /usr/local/lib/python3.8/dist-packages/object_detection/model_lib_v2.py:563: StrategyBase.experimental_distribute_datasets_from_function (from tensorflow.python.dist  
Instructions for updating:  
rename to distribute_datasets_from_function  
W1208 06:13:49.516993 139860059768704 deprecation.py:350] From /usr/local/lib/python3.8/dist-packages/object_detection/model_lib_v2.py:563: StrategyBase.experimental_distribute_datasets_from  
Instructions for updating:  
rename to distribute_datasets_from_function  
INFO:tensorflow:Reading unweighted datasets: ['/content/gdrive/MyDrive/VideoAnalyticsProjectStuff/Dataset/train_labels']  
I1208 06:13:49.535931 139860059768704 dataset_builder.py:162] Reading unweighted datasets: ['/content/gdrive/MyDrive/VideoAnalyticsProjectStuff/Dataset/train_labels']  
INFO:tensorflow:Reading record datasets for input file: ['/content/gdrive/MyDrive/VideoAnalyticsProjectStuff/Dataset/train_labels']  
I1208 06:13:49.536573 139860059768704 dataset_builder.py:79] Reading record datasets for input file: ['/content/gdrive/MyDrive/VideoAnalyticsProjectStuff/Dataset/train_labels']  
INFO:tensorflow:Number of filenames to read: 1  
I1208 06:13:49.536770 139860059768704 dataset_builder.py:80] Number of filenames to read: 1
```

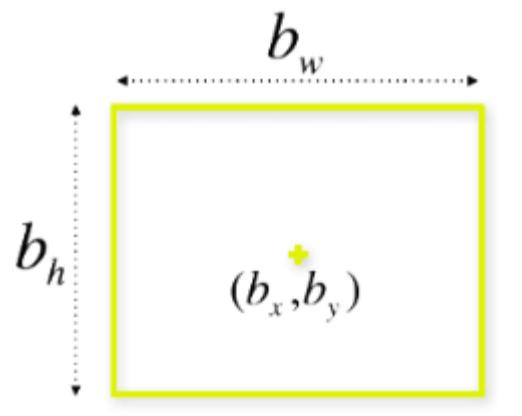
Compatibility Problems

YOLO

Architecture

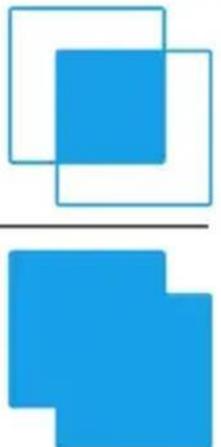


$$y = (p_c, b_x, b_y, b_h, b_w, c)$$



$$Loss = \lambda_1 L_{cls} + \lambda_2 L_{obj} + \lambda_3 L_{loc}$$

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$



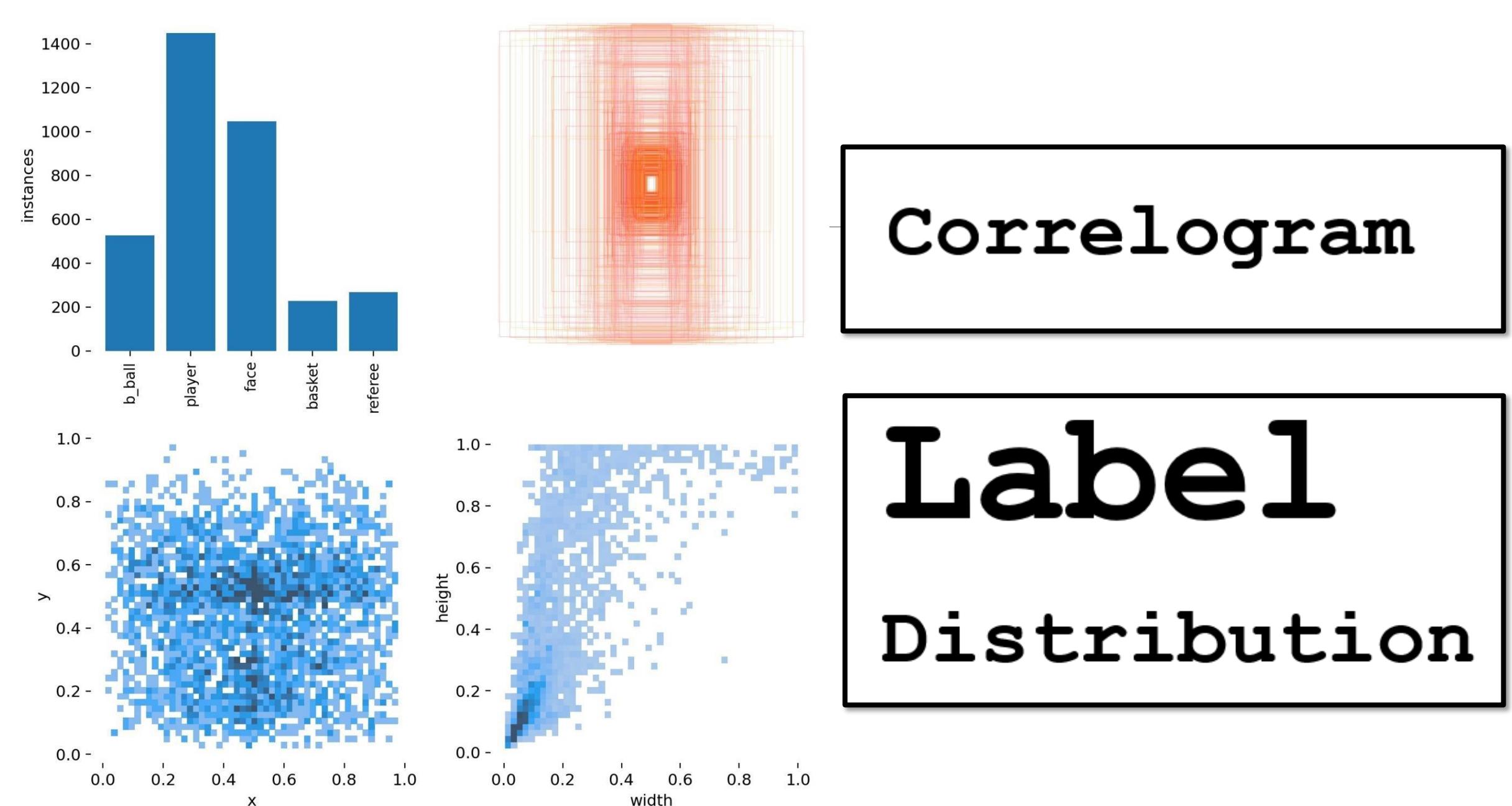
Model	size (pixels)	mAP ^{box} 50-95	mAP ^{mask} 50-95	Train time 300 epochs A100 (hours)	Speed ONNX CPU (ms)	Speed TRT A100 (ms)	params (M)	FLOPs @640 (B)
YOLOv5n-seg	640	27.6	23.4	80:17	62.7	1.2	2.0	7.1
YOLOv5s-seg	640	37.6	31.7	88:16	173.3	1.4	7.6	26.4
YOLOv5m-seg	640	45.0	37.1	108:36	427.0	2.2	22.0	70.8
YOLOv5l-seg	640	49.0	39.9	66:43 (2x)	857.4	2.9	47.9	147.7
YOLOv5x-seg	640	50.7	41.4	62:56 (3x)	1579.2	4.5	88.8	265.7

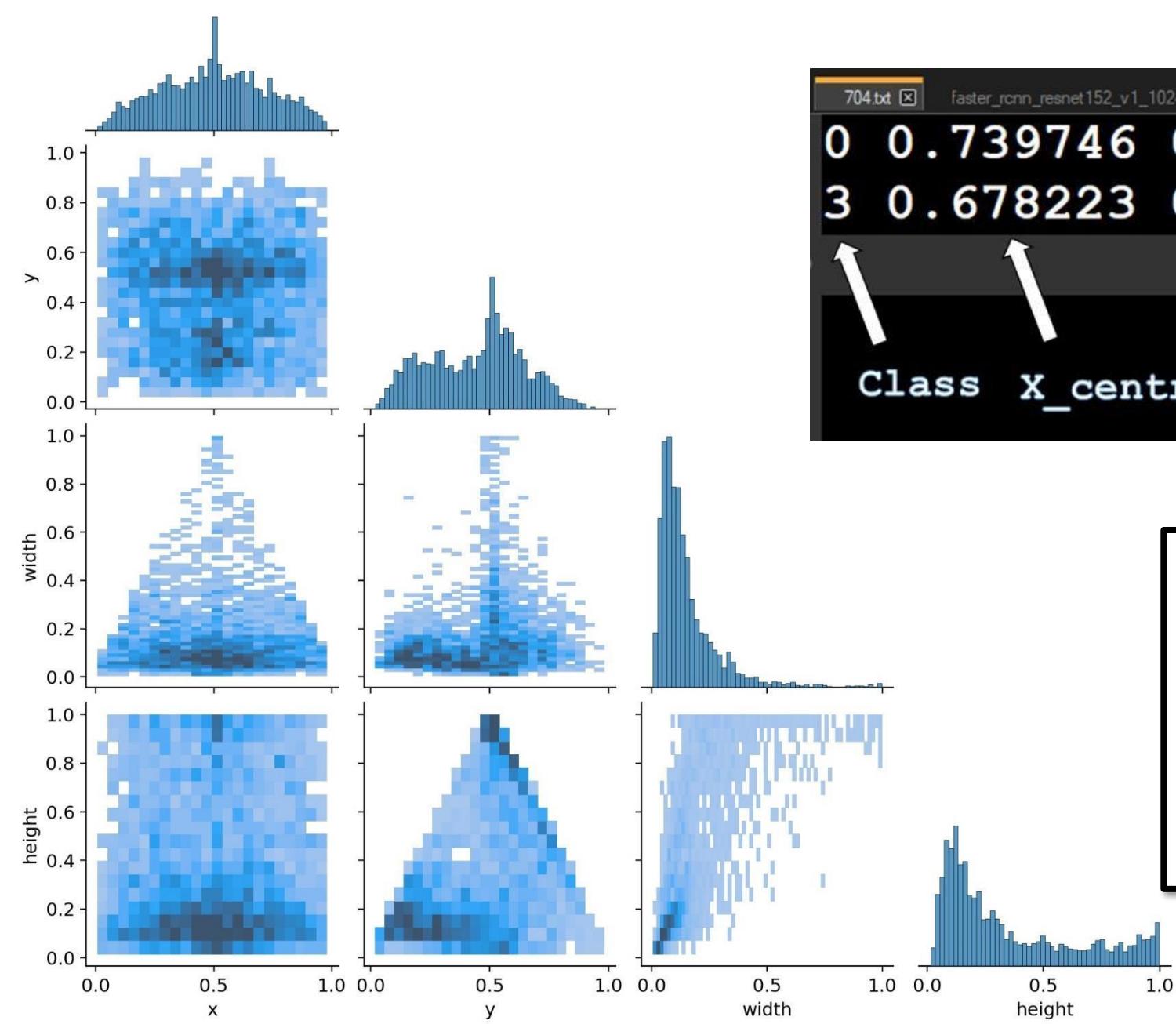
YOLO

PreTrained Weights

Sliding Window Object Detection → R CNN → Fast R CNN → Faster R CNN → YOLO

Algorithm Efficiency





704.txt faster_rcnn_resnet152_v1_1024x1024_coco17_tpu-8.config pipeline.config compare-train.ipynb pipeline (1).config

0	0.739746	0.785933	0.303711	0.388379
3	0.678223	0.360092	0.504883	0.701835

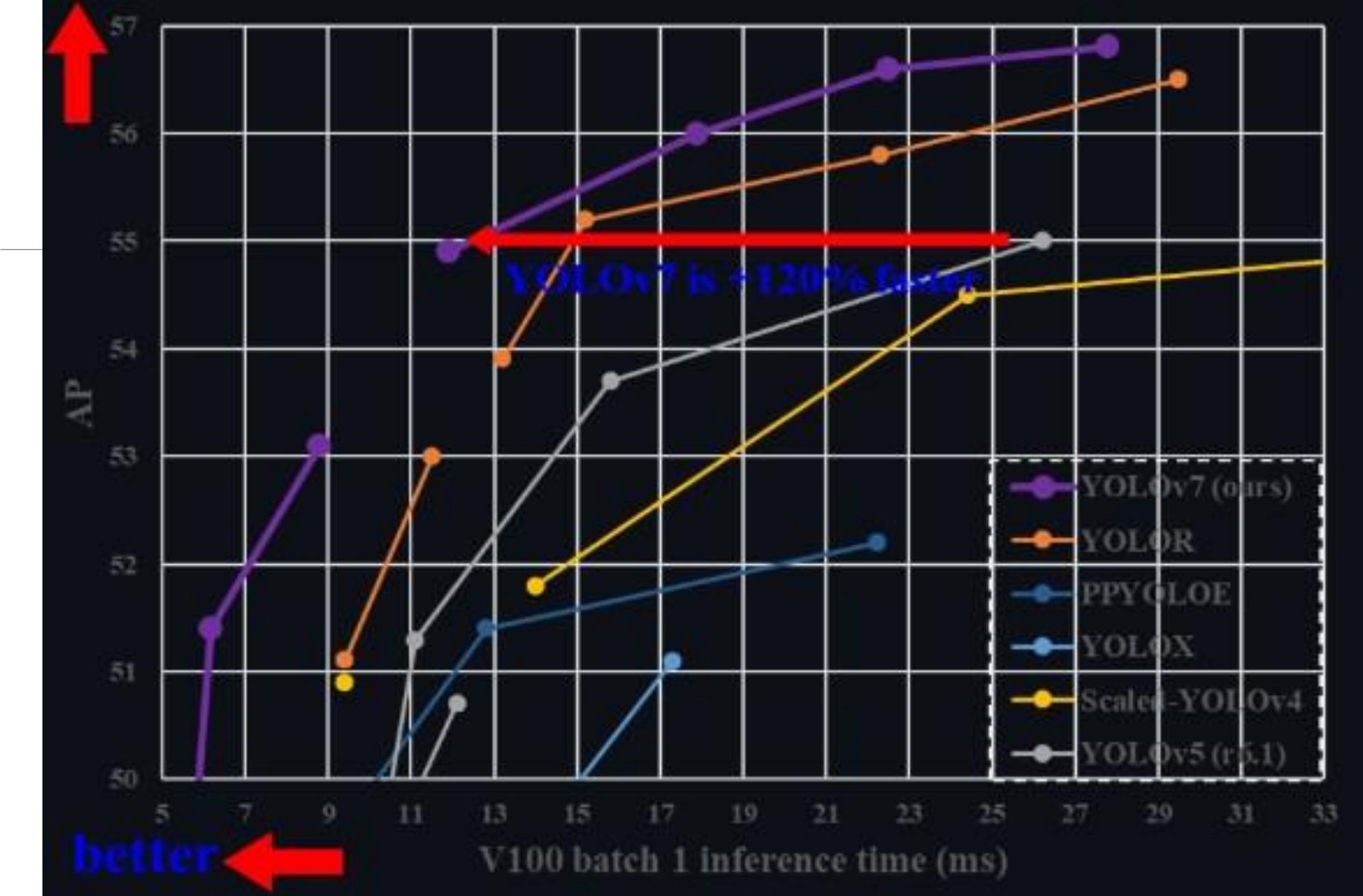
Class X_centre Y_centre Width Height

Label Correlation

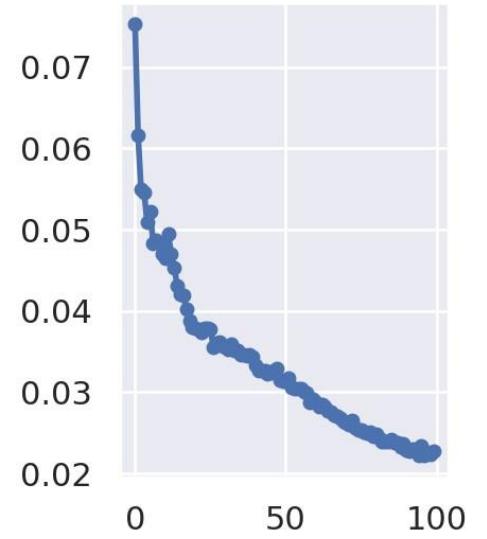
```
!python train.py --batch 8 --epochs 50 --data /content/drive/MyDrive/Yolo_Stuff/dataset.yaml --weights /content/yolov5/yolov5s.pt --nosave --cache  
image sizes 640 train, 640 val  
Using 2 dataloader workers  
Logging results to runs/train/exp5  
Starting training for 50 epochs...
```

Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
0/49	1.99G	0.0974	0.07986	0.04691	77	640: 100% 78/78 [00:15<00:00, 4.99it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:02<00:00, 4.53it/s]
	all	151	773	0.153	0.305	0.184	0.0588
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
1/49	2.54G	0.07544	0.06746	0.03181	63	640: 100% 78/78 [00:12<00:00, 6.16it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 6.58it/s]
	all	151	773	0.599	0.369	0.247	0.096
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
2/49	2.54G	0.0734	0.0604	0.02605	73	640: 100% 78/78 [00:12<00:00, 6.20it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 7.32it/s]
	all	151	773	0.24	0.59	0.394	0.135
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
3/49	2.54G	0.06622	0.06	0.02323	39	640: 100% 78/78 [00:12<00:00, 6.20it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 7.77it/s]
	all	151	773	0.587	0.601	0.522	0.212
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
4/49	2.54G	0.06107	0.06066	0.02062	67	640: 100% 78/78 [00:12<00:00, 6.09it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 7.72it/s]
	all	151	773	0.674	0.565	0.609	0.261
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
5/49	2.54G	0.0583	0.05828	0.02002	88	640: 100% 78/78 [00:12<00:00, 6.23it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 7.68it/s]
	all	151	773	0.744	0.664	0.658	0.289
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
6/49	2.54G	0.05396	0.05766	0.01784	59	640: 100% 78/78 [00:12<00:00, 6.20it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 7.93it/s]
	all	151	773	0.805	0.679	0.697	0.314
Epoch	GPU_mem	box_loss	obj_loss	cls_loss	Instances	Size	
7/49	2.54G	0.052	0.05856	0.01869	86	640: 100% 78/78 [00:12<00:00, 6.22it/s]	
	Class	Images	Instances	P	R	mAP50	mAP50-95: 100% 10/10 [00:01<00:00, 7.96it/s]
	all	151	773	0.813	0.677	0.716	0.336

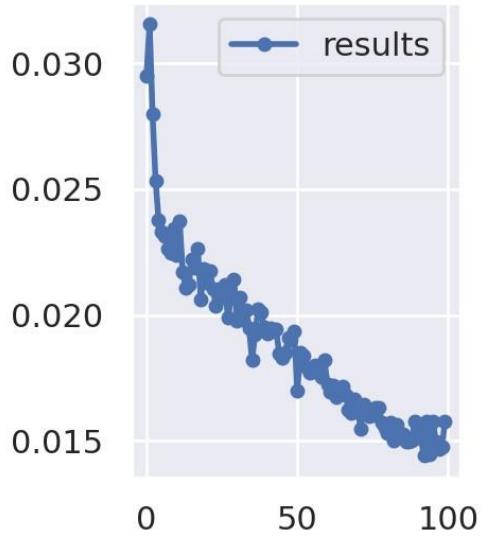
Training the Model



Box



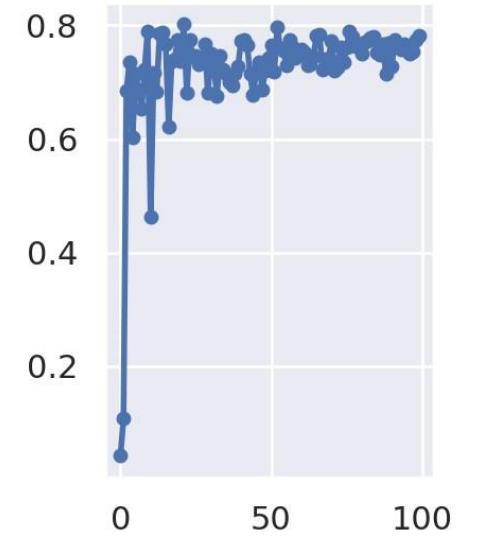
Objectness



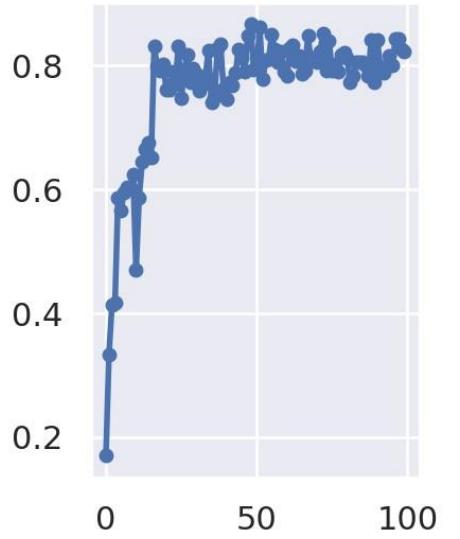
Classification



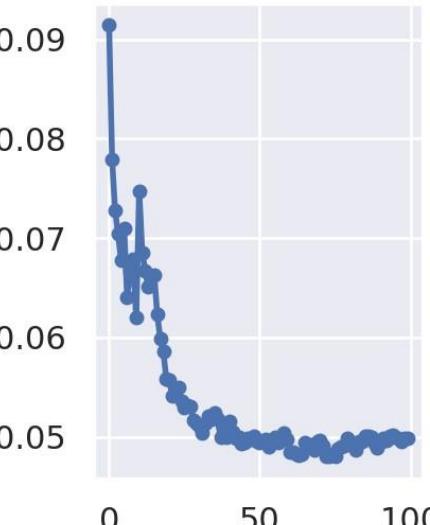
Precision



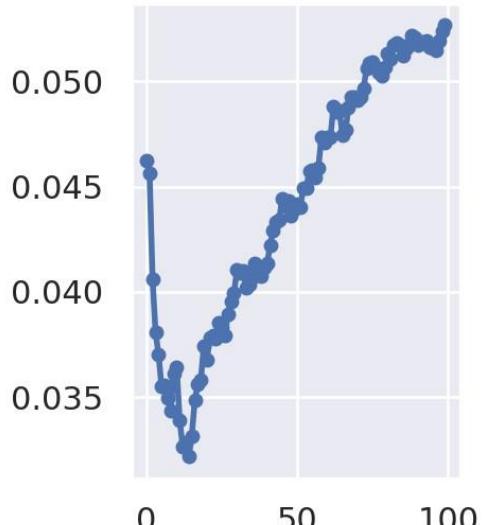
Recall



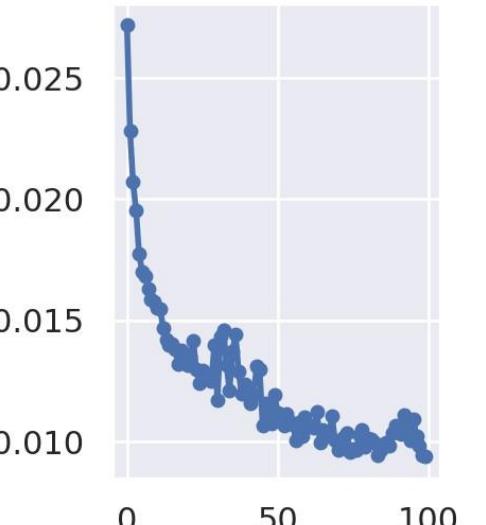
val Box



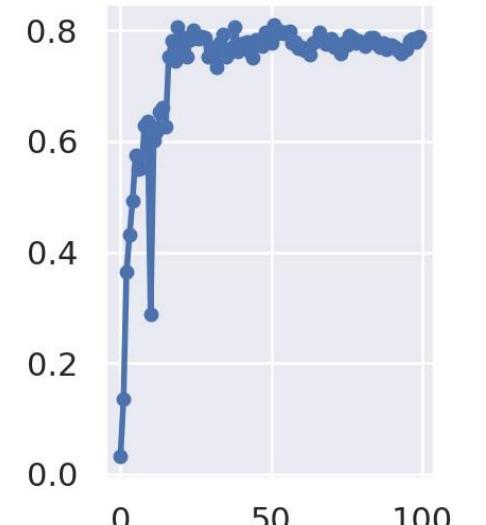
val Objectness



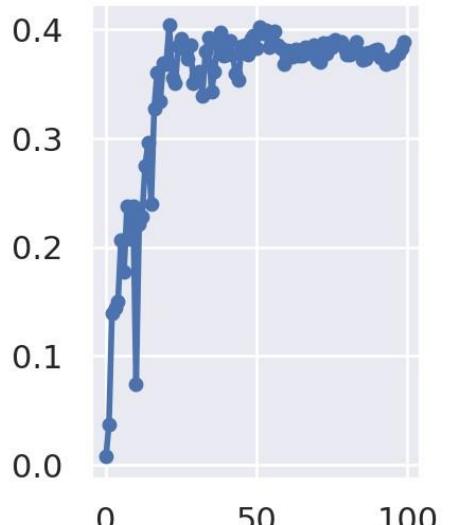
val Classification

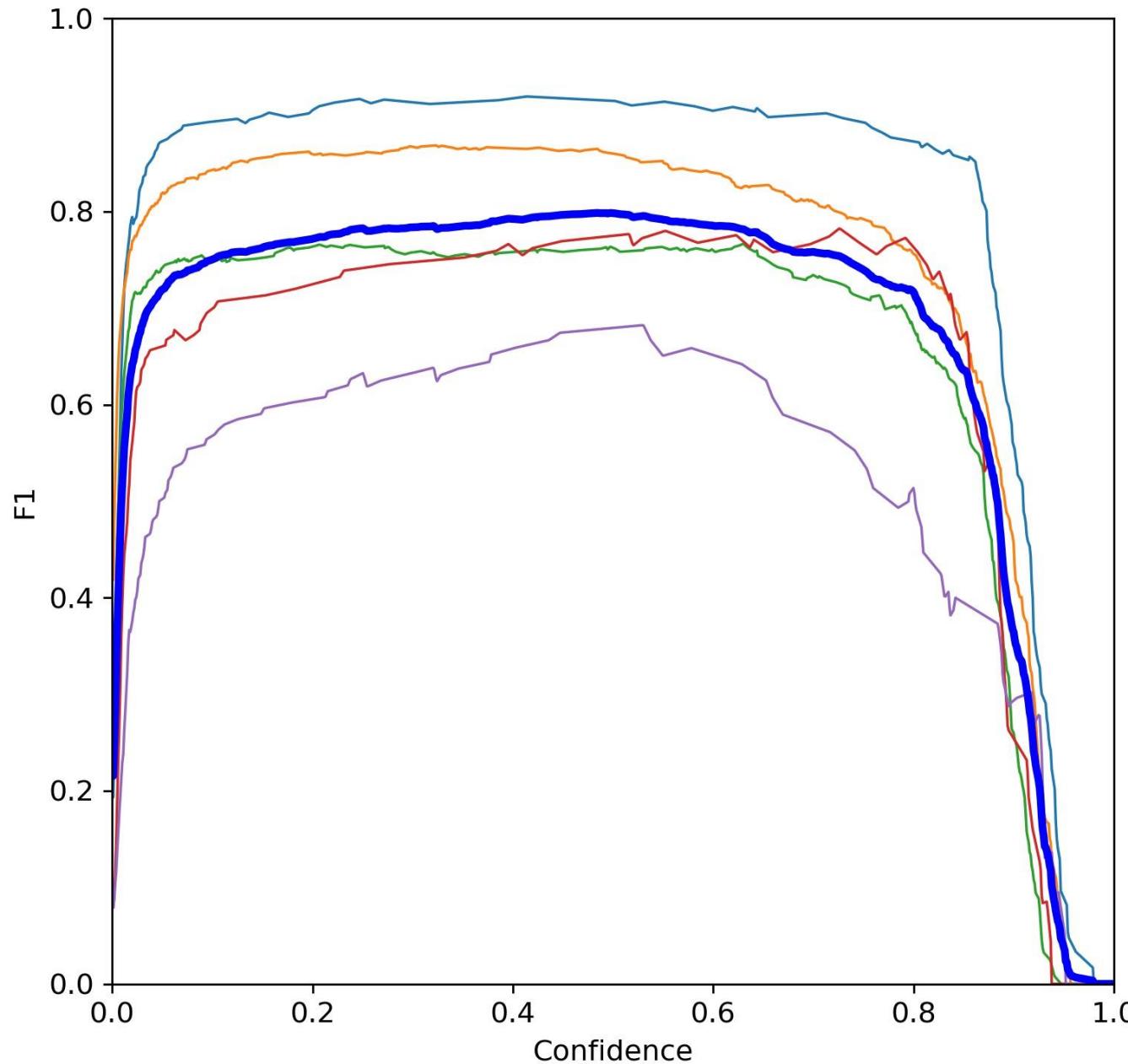


mAP@0.5

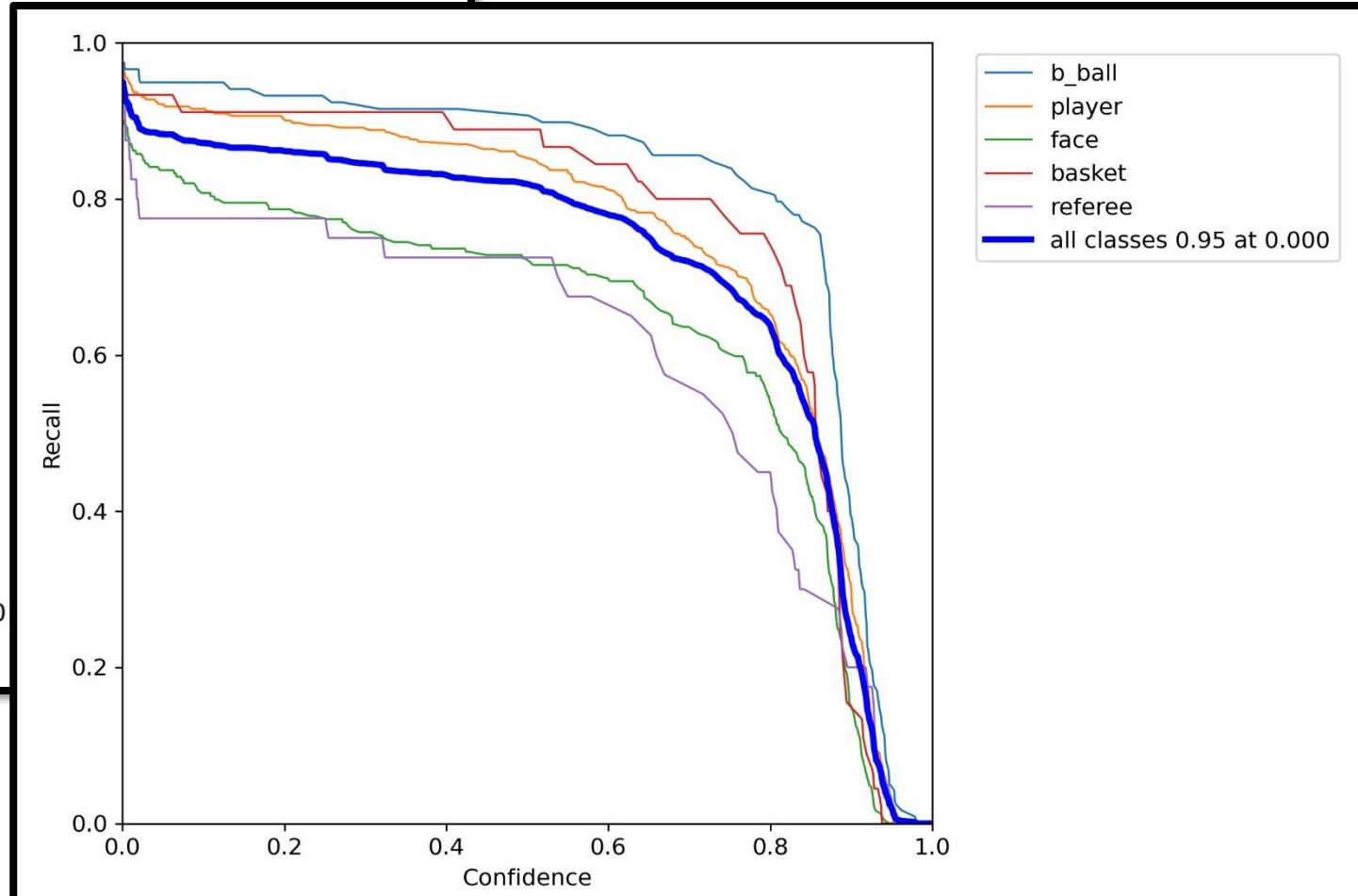
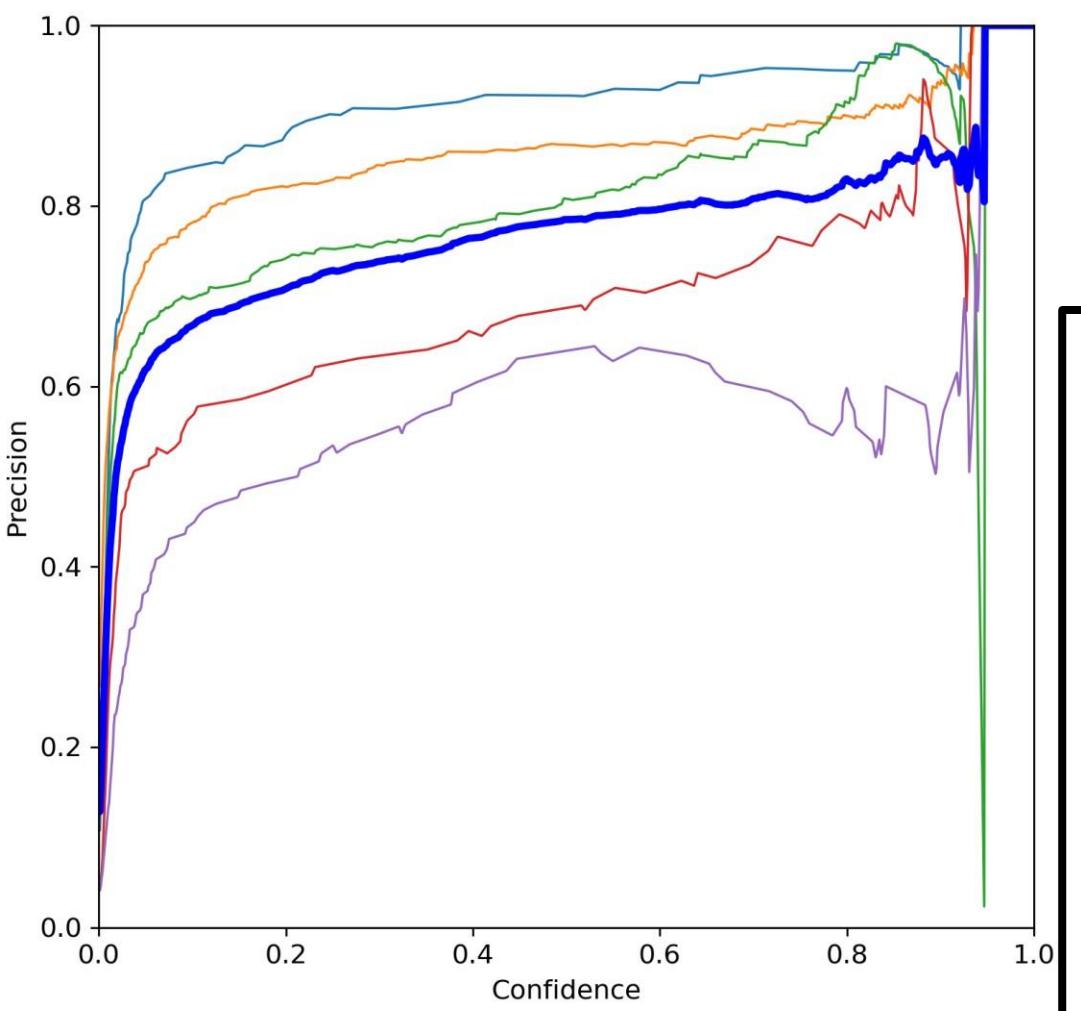


mAP@0.5:0.95





F1 Curve



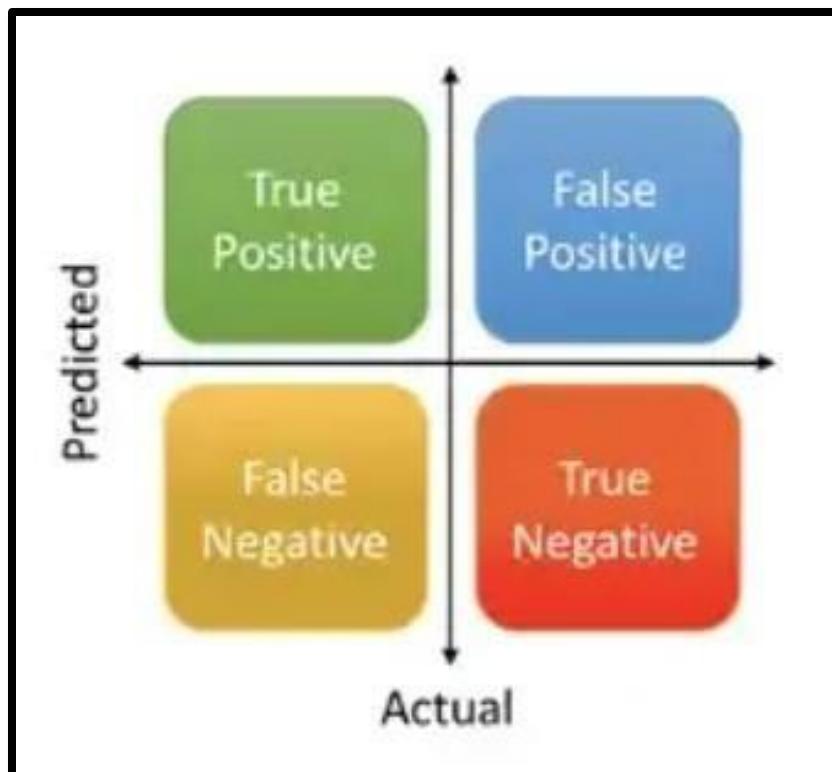
$$\text{Precision} = \frac{\text{True Positive}}{\text{Actual Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}$$

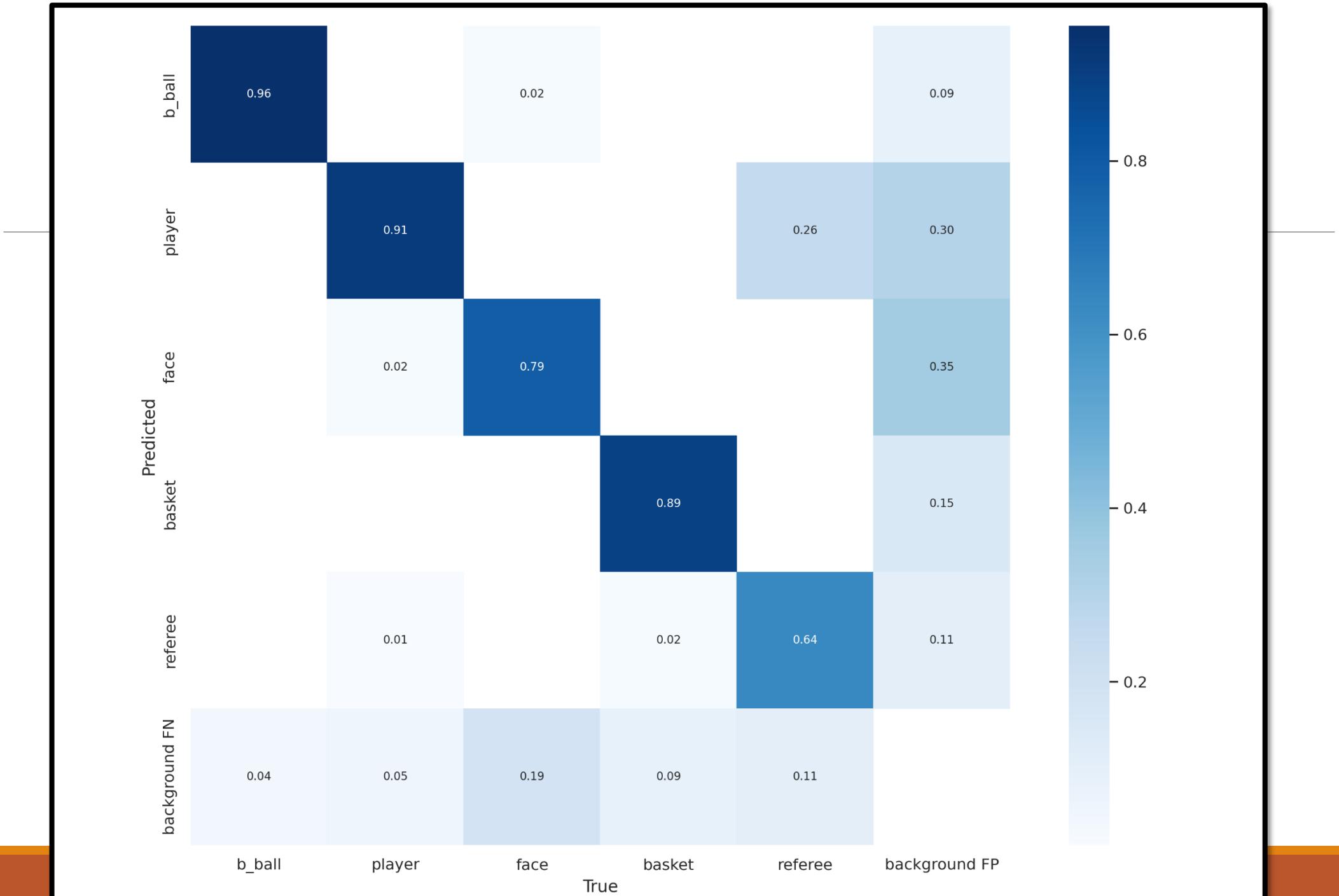
$$\text{Recall} = \frac{\text{True Positive}}{\text{Predicted Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}}$$

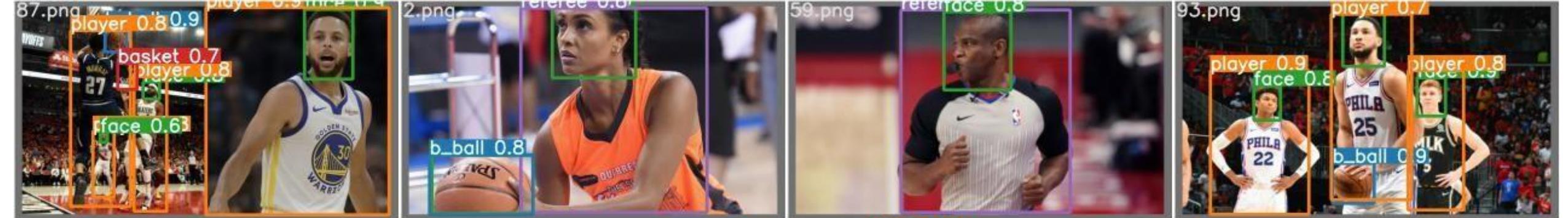
$$\text{Accuracy} = \frac{\text{True Positive} + \text{True Negative}}{\text{Total}}$$

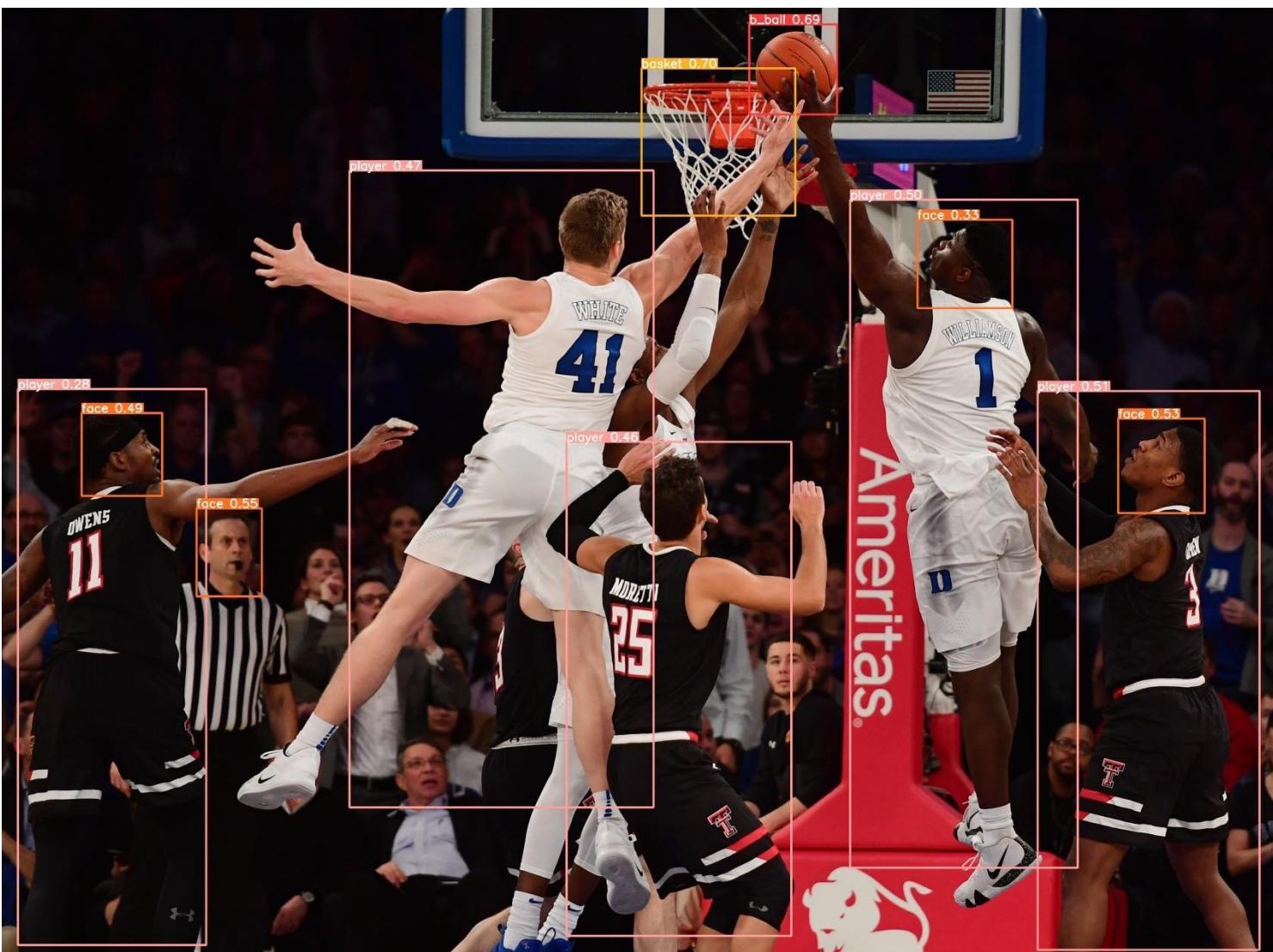
Formulation

Confusion Matrix

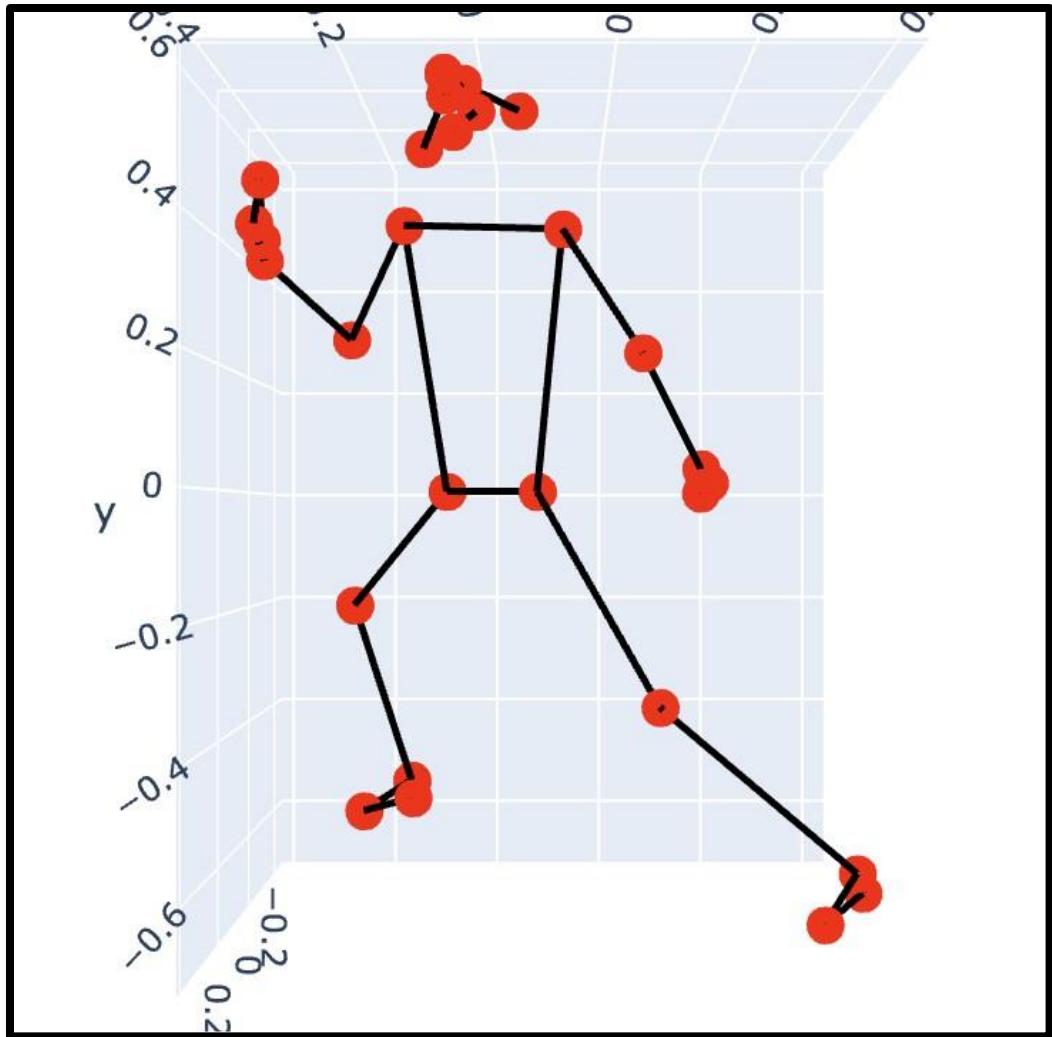






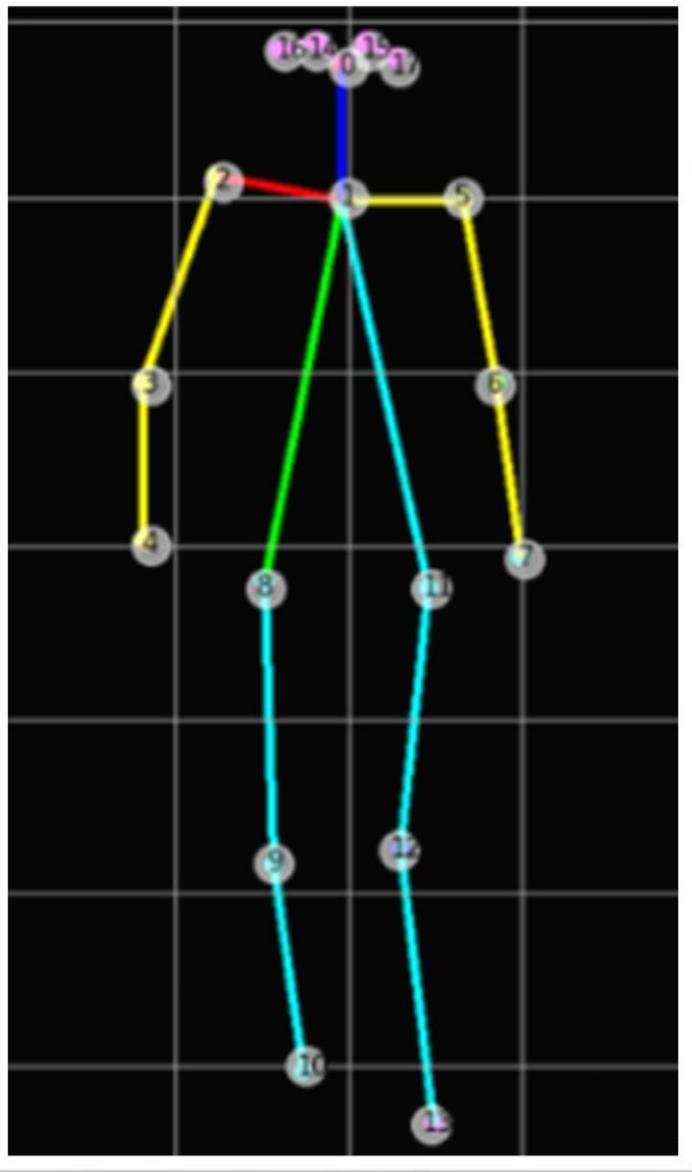






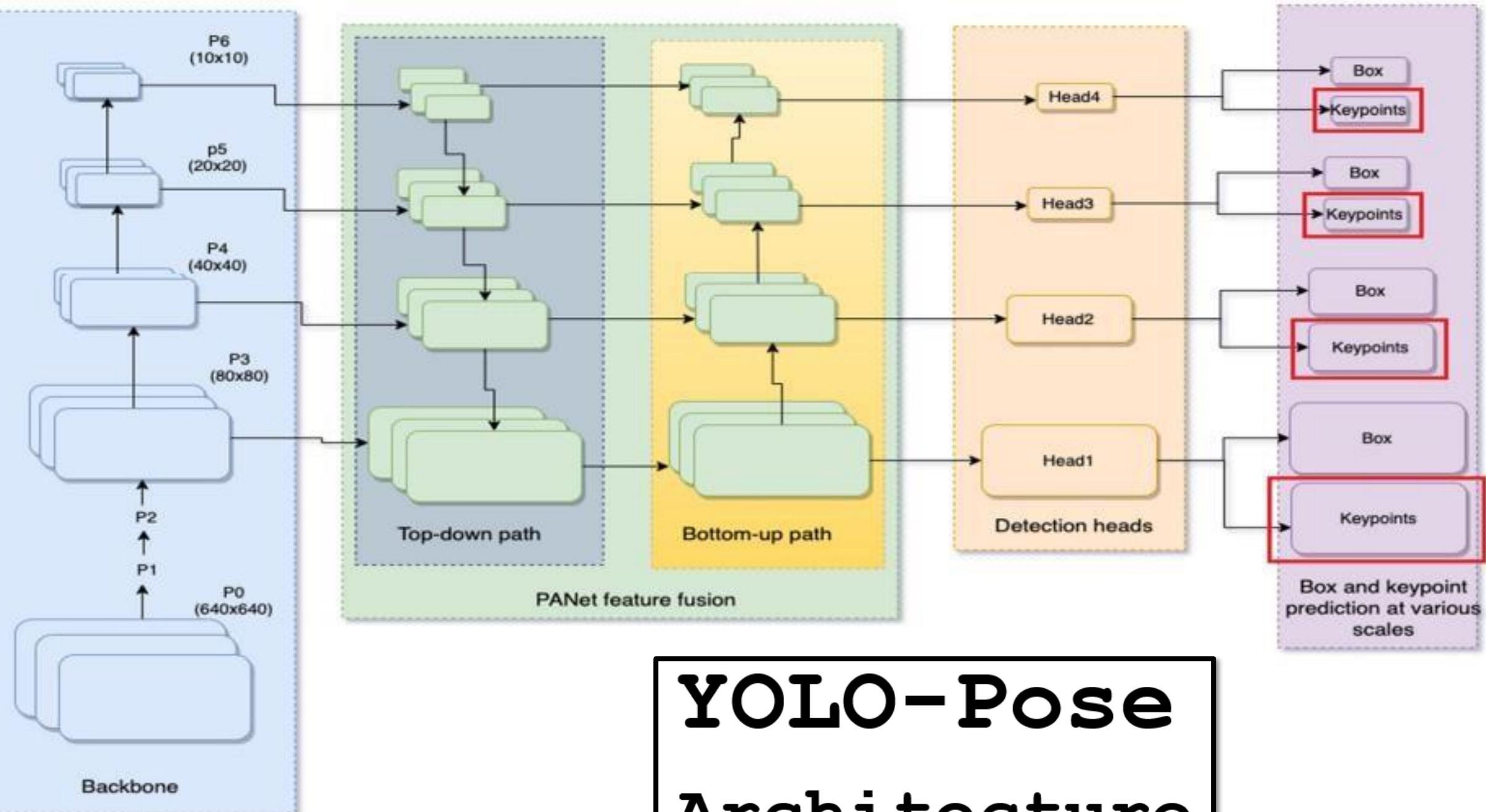
MediaPipe

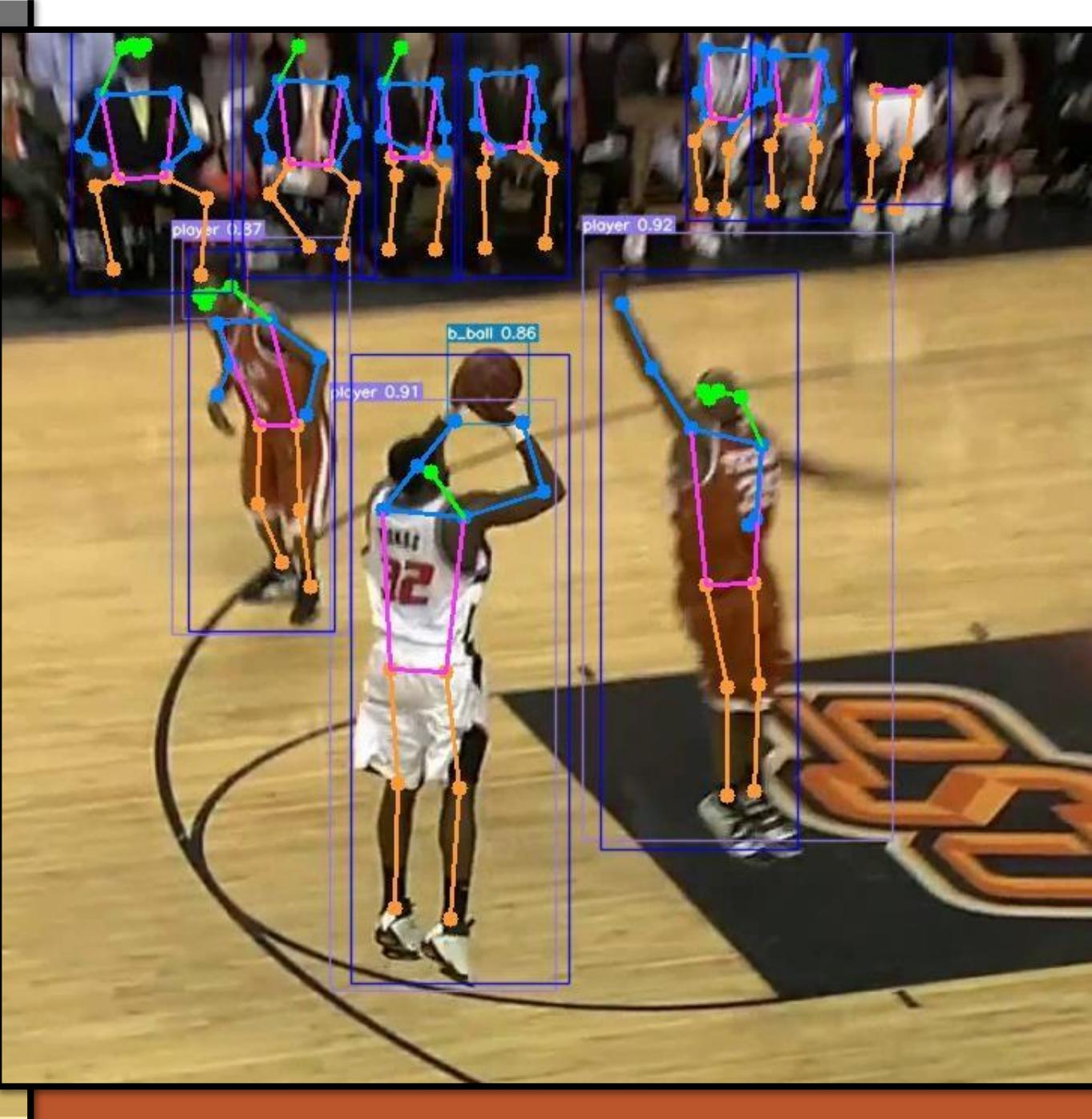
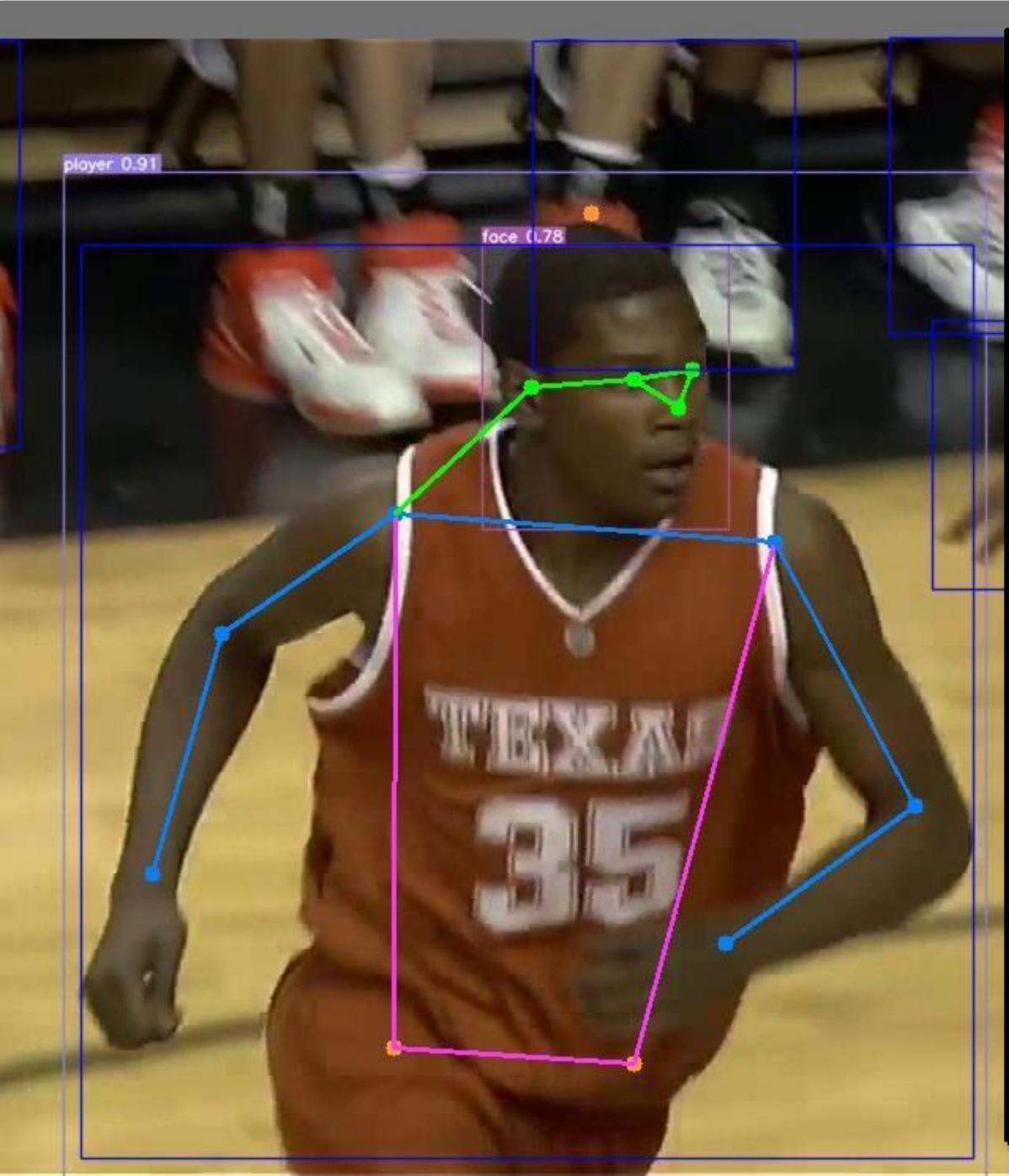
**32 Key
Points**

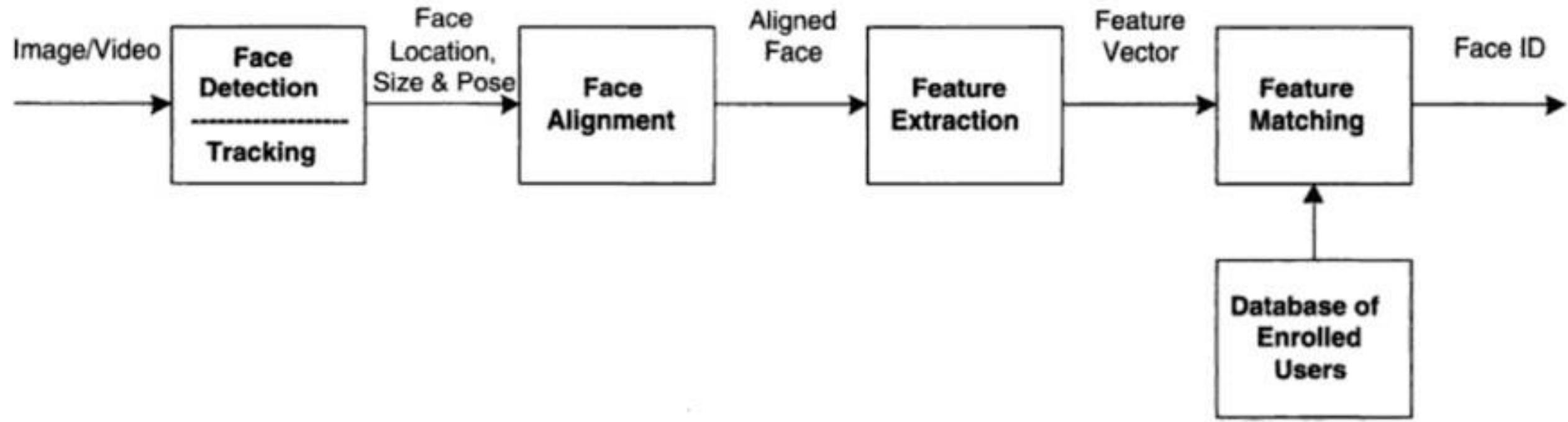


YOLO-Pose

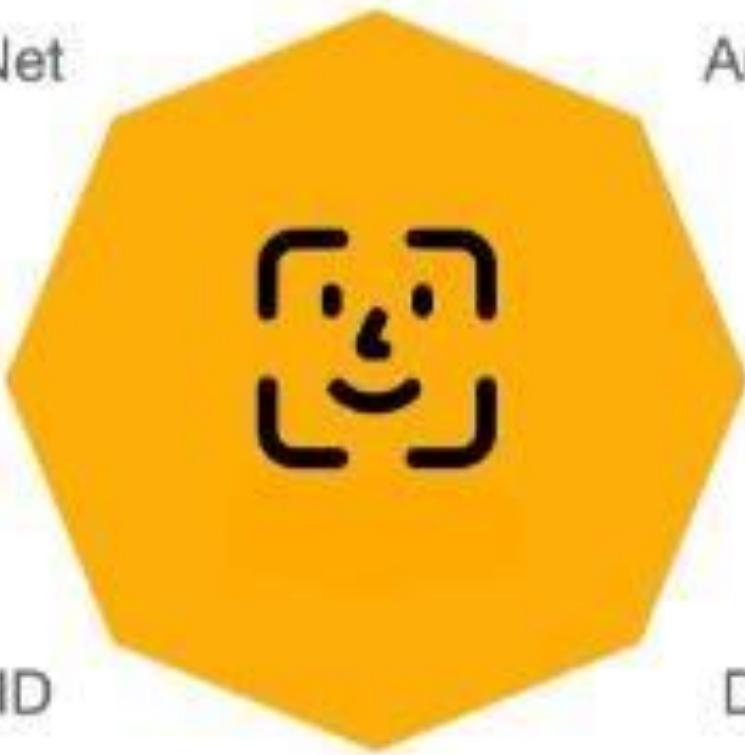
17 Key
Points







Face recognition processing flow.



VGG-Face

FaceNet

Dlib

DeepID

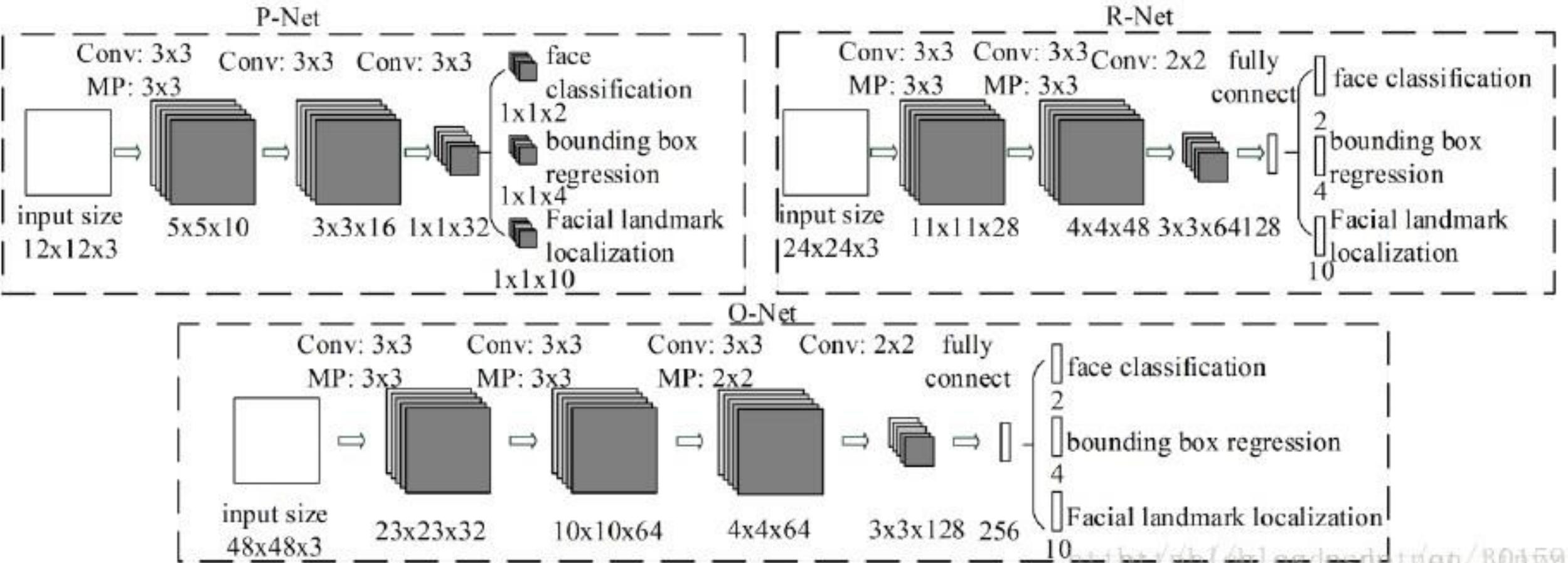
SFace

ArcFace

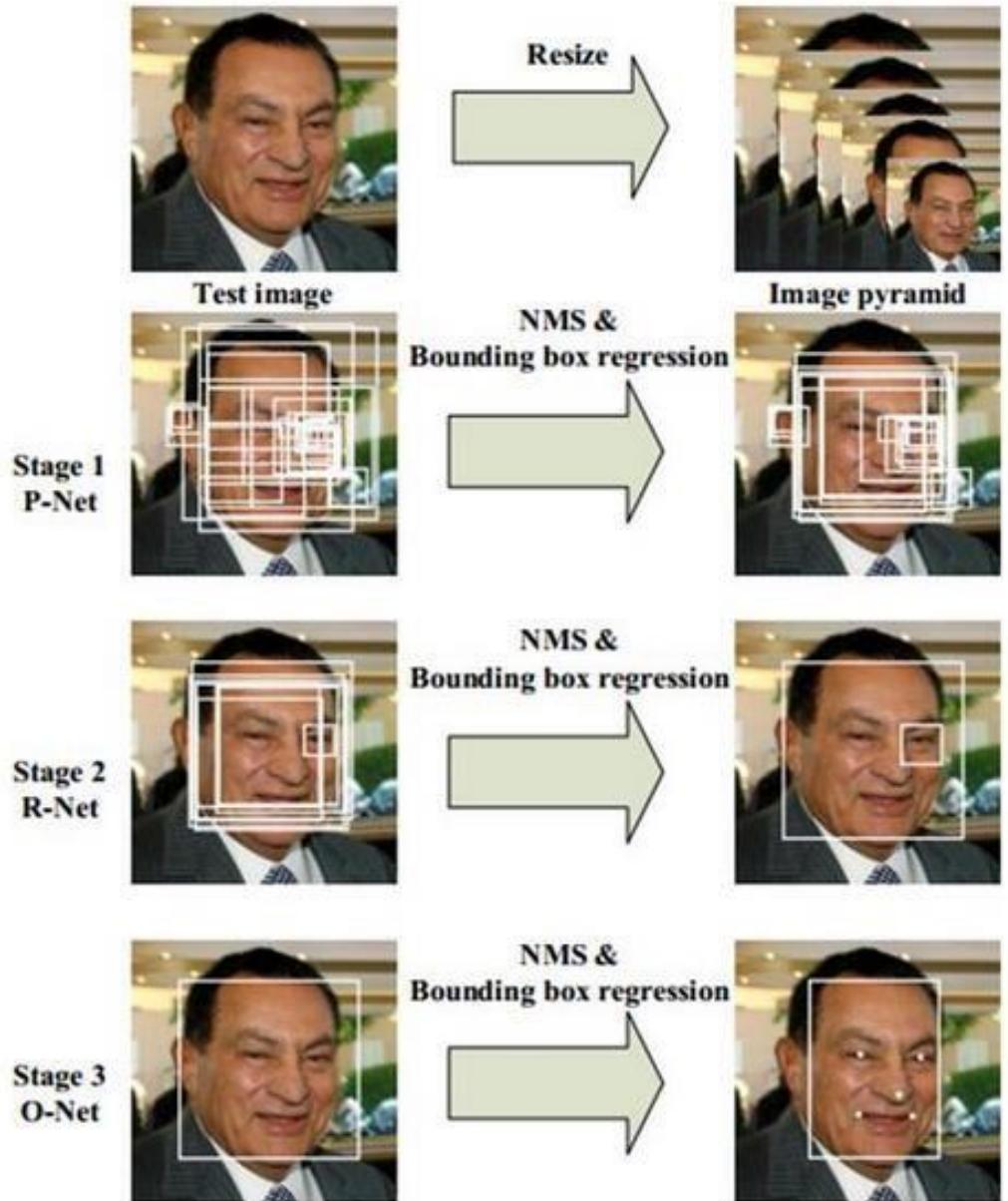
OpenFace

DeepFace

	Cosine	Euclidean	Euclidean L2
VGGFace	Threshold: 0.31 Accuracy: 89.28 Precision: 97.41 Recall: 80.71 F1: 88.28	Threshold: 0.47 Accuracy: 81.42 Precision: 97.82 Recall: 64.28 F1: 77.58	Threshold: 0.79 Accuracy: 89.28 Precision: 97.41 Recall: 80.71 F1: 88.28
FaceNet	Threshold: 0.40 Accuracy: 98.21 Precision: 100 Recall: 96.42 F1: 98.18	Threshold: 11.26 Accuracy: 98.57 Precision: 100 Recall: 97.14 F1: 98.55	Threshold: 0.90 Accuracy: 98.21 Precision: 100 Recall: 96.42 F1: 98.18
OpenFace	Threshold: 0.11 Accuracy: 57.85 Precision: 95.83 Recall: 16.42 F1: 28.04	Threshold: 0.47 Accuracy: 57.85 Precision: 95.83 Recall: 16.42 F1: 28.04	Threshold: 0.47 Accuracy: 57.85 Precision: 95.83 Recall: 16.42 F1: 28.04
DeepFace	Threshold: 0.13 Accuracy: 54.64 Precision: 100 Recall: 9.28 F1: 16.99	Threshold: 42.21 Accuracy: 52.50 Precision: 100 Recall: 5.00 F1: 9.52	Threshold: 0.51 Accuracy: 54.64 Precision: 100 Recall: 9.28 F1: 16.99

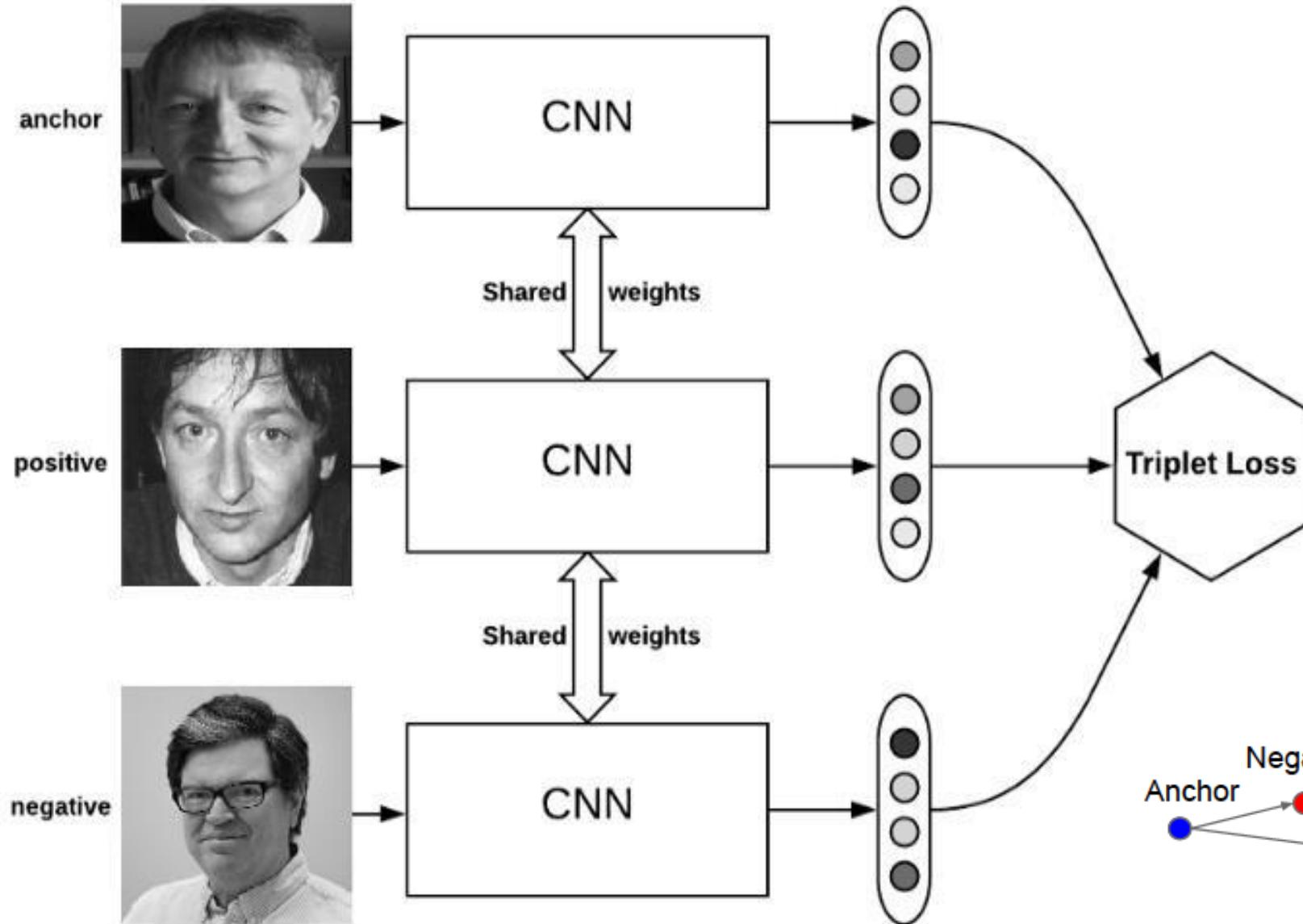


MTCNN



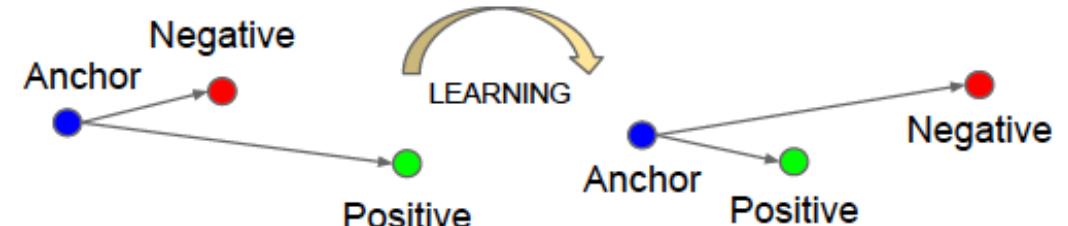
MTCNN

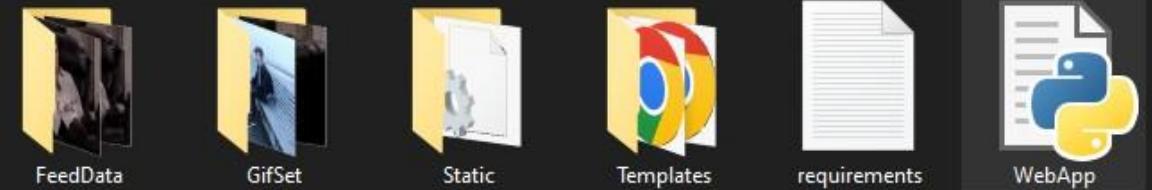
Embeddings



Triple Loss

FaceNet



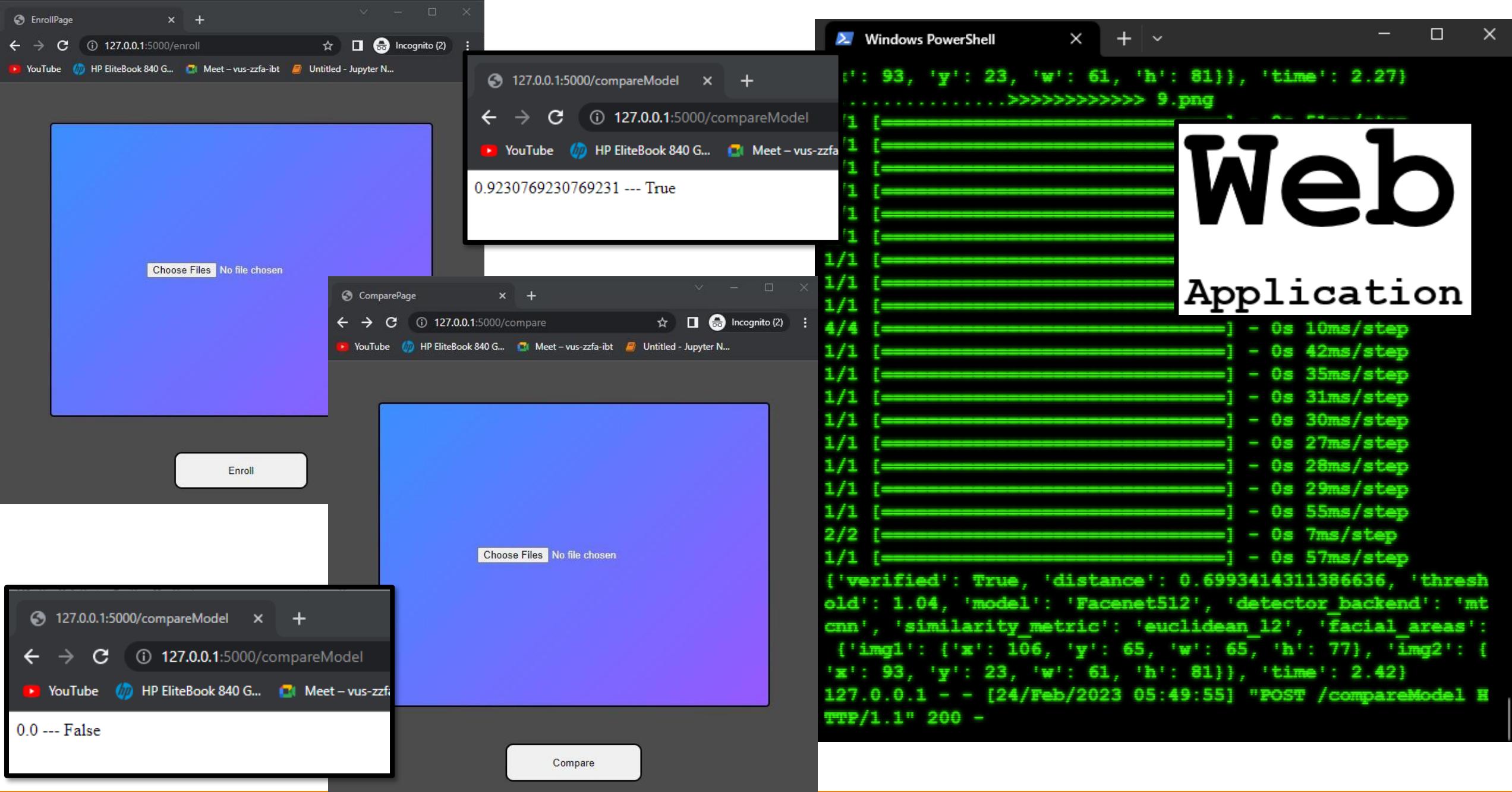


```
Windows PowerShell
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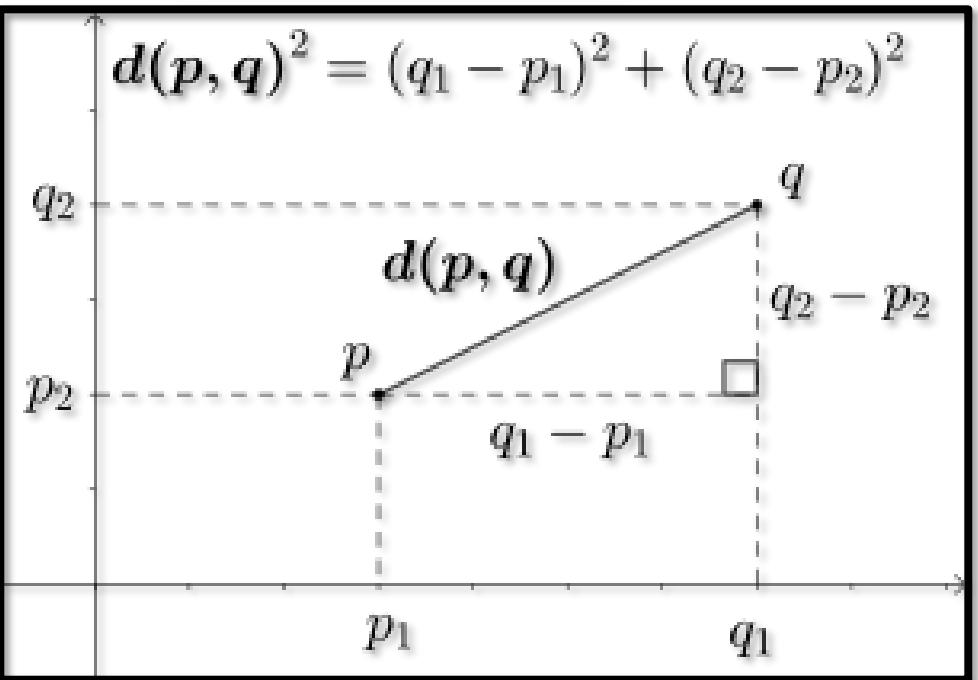
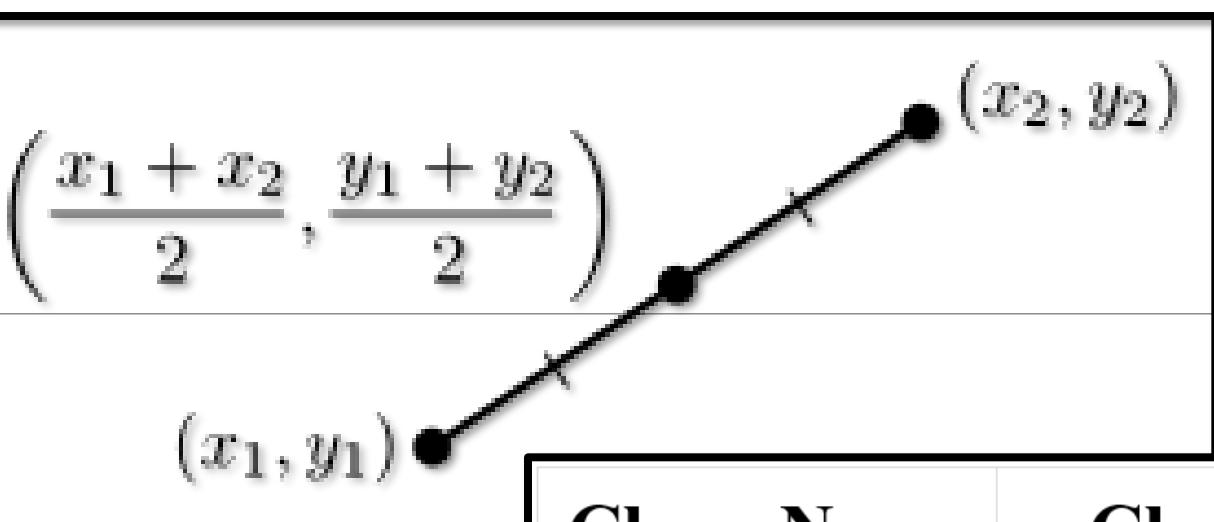
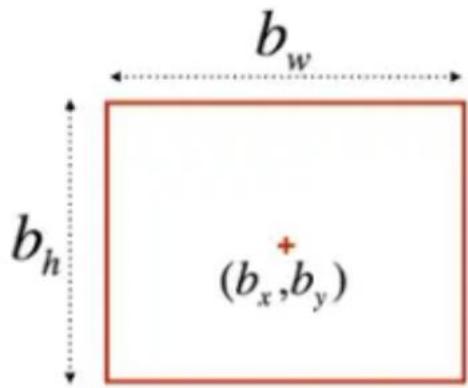
Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\Users\Rahman> cd "N:\BioToneFaceModel"
PS N:\BioToneFaceModel> py WebApp.py
 * Serving Flask app 'WebApp' (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production
   deployment.
   Use a production WSGI server instead.
 * Debug mode: on
WARNING: This is a development server. Do not use it in a production de
ployment. Use a production WSGI server
 * Running on http://127.0.0.1:5000
Press CTRL+C to quit
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 654-001-028
```

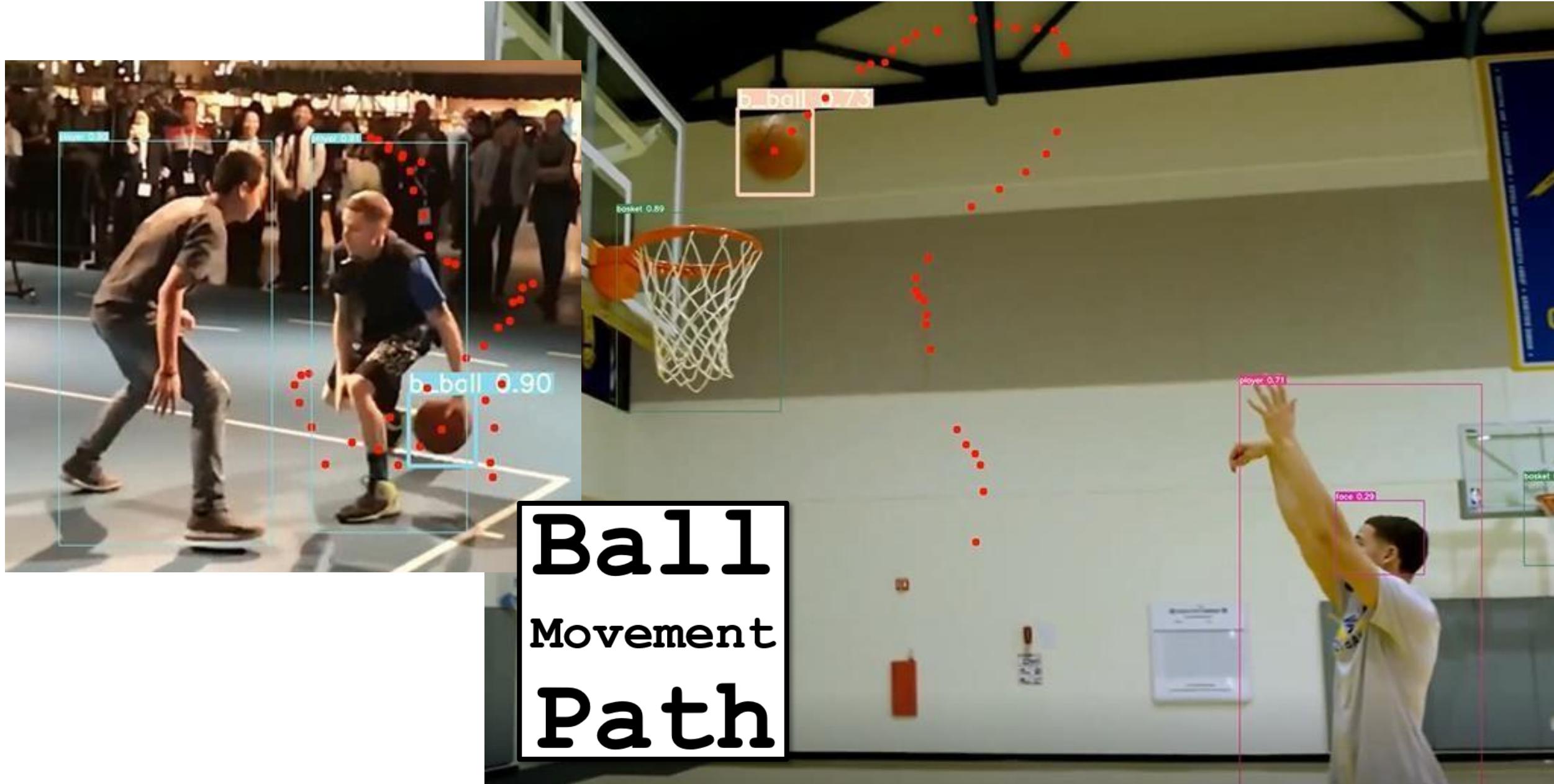
File
Structure

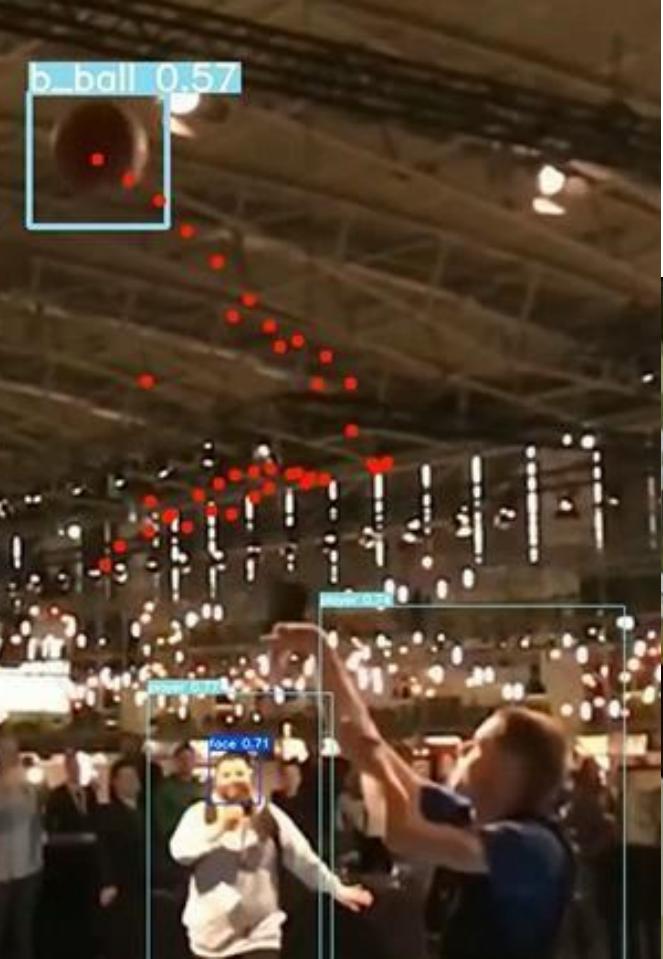
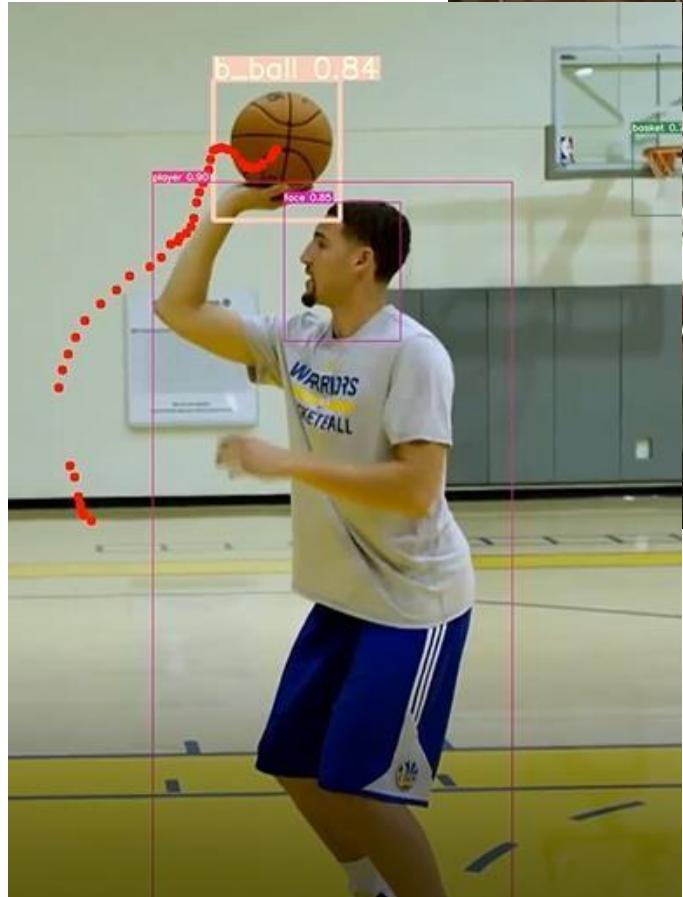


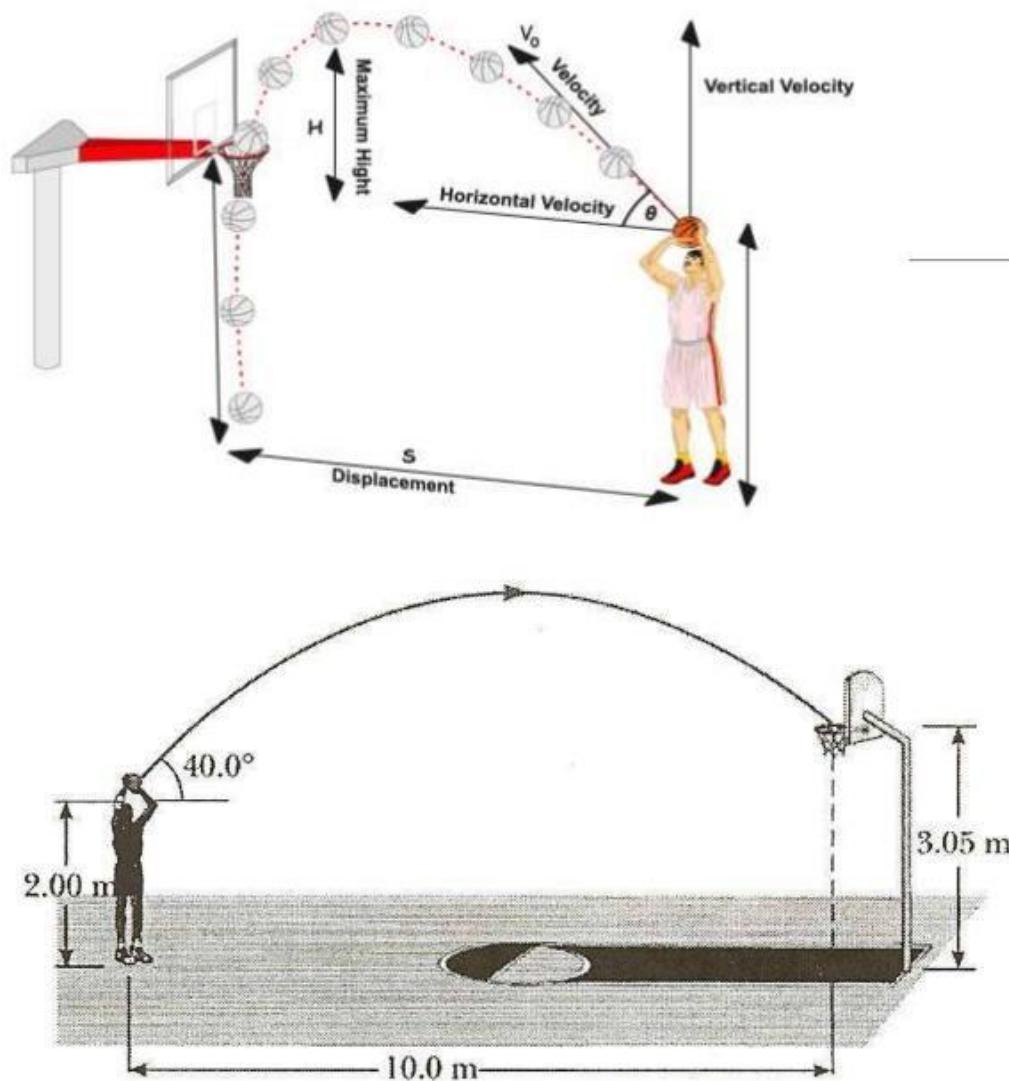
$$y = (p_c, b_x, b_y, b_h, b_w, c)$$



Class_Name	Class_id
b_ball	0
player	1
face	2
basket	3
referee	4

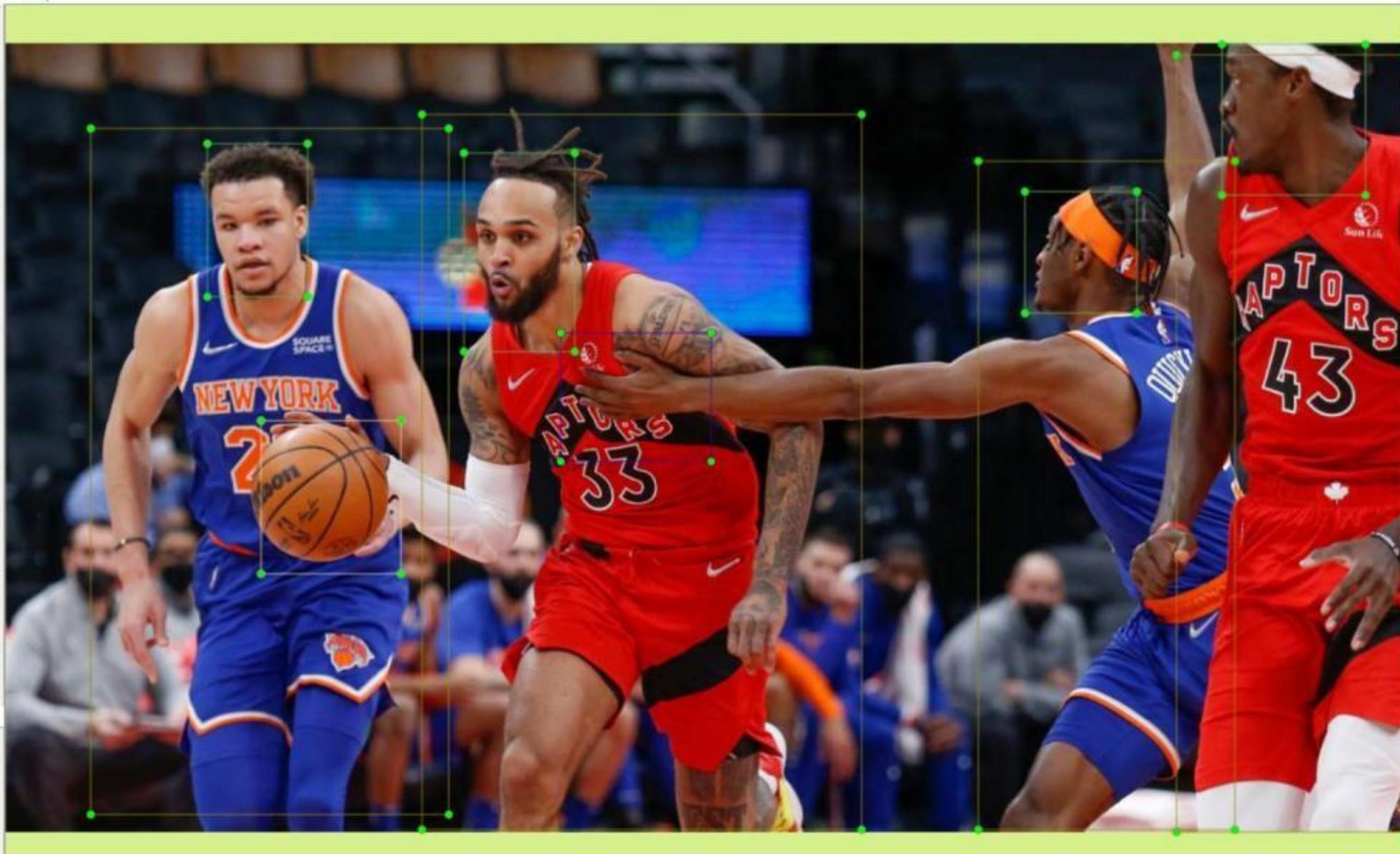






$$x = x_0 + (v_0 \cdot \cos \theta) \cdot t$$

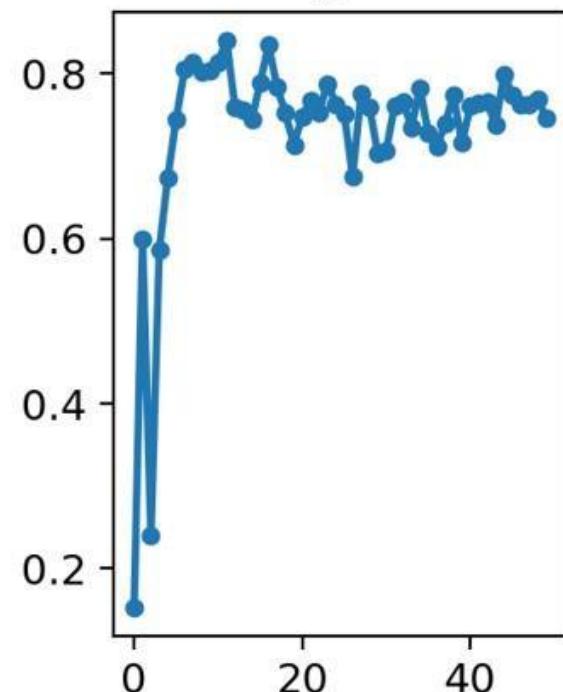
$$y = y_0 + (v_0 \cdot \sin \theta) \cdot t - \frac{1}{2}gt^2$$



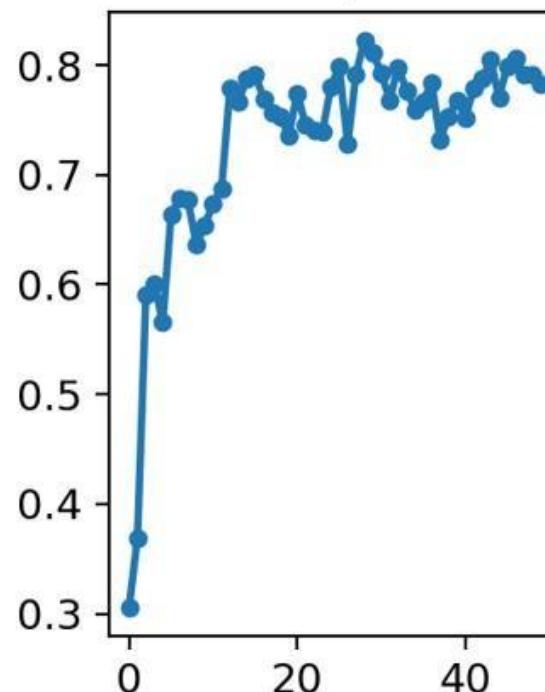
Click & drag to move shape 'player'

X: 831; Y: 213

metrics/precision



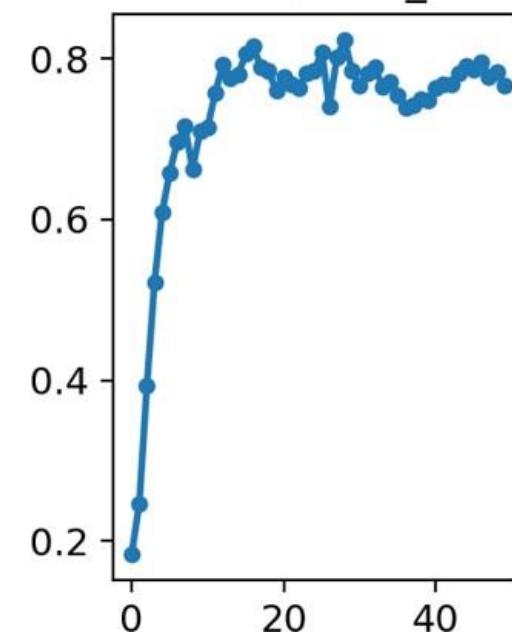
metrics/recall



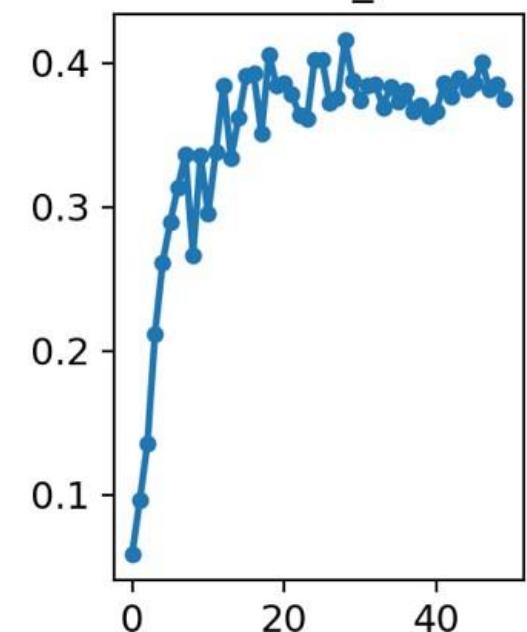
Model Visualisation

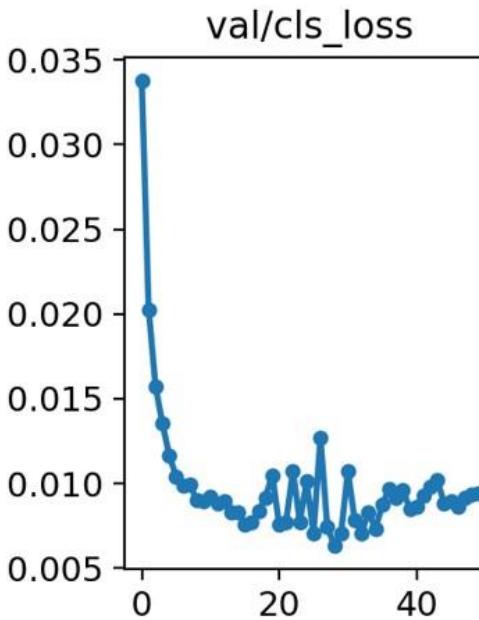
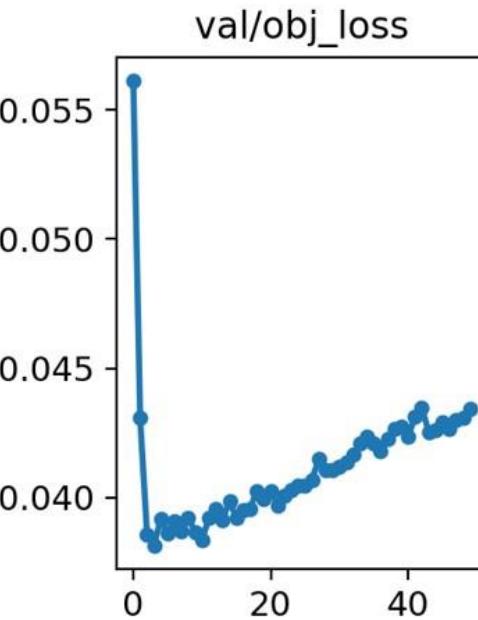
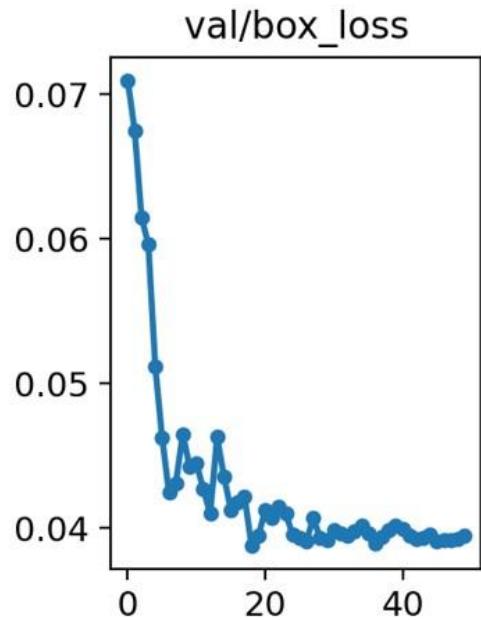
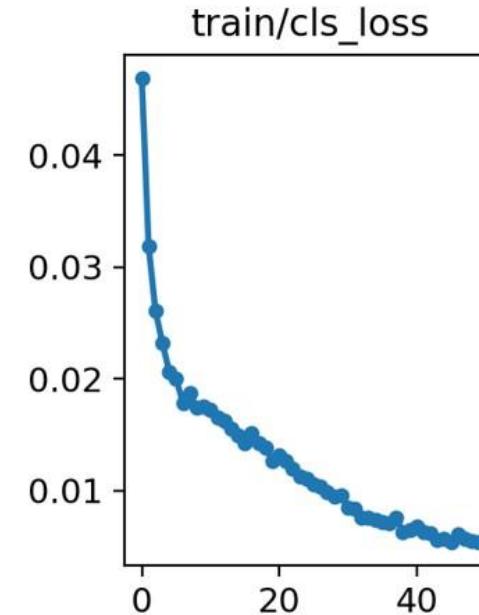
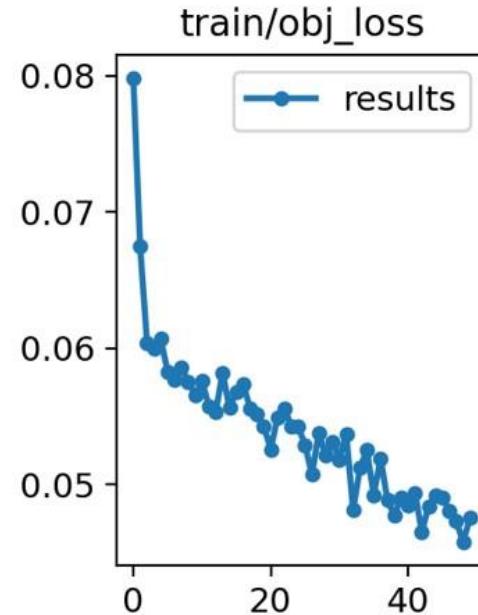
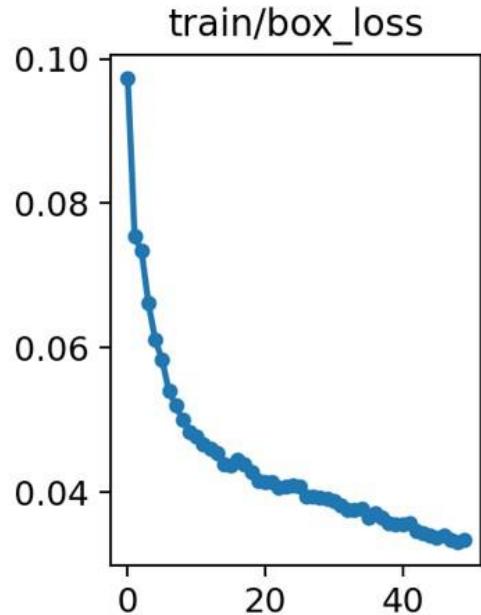
50 Epoch

metrics/mAP_0.5

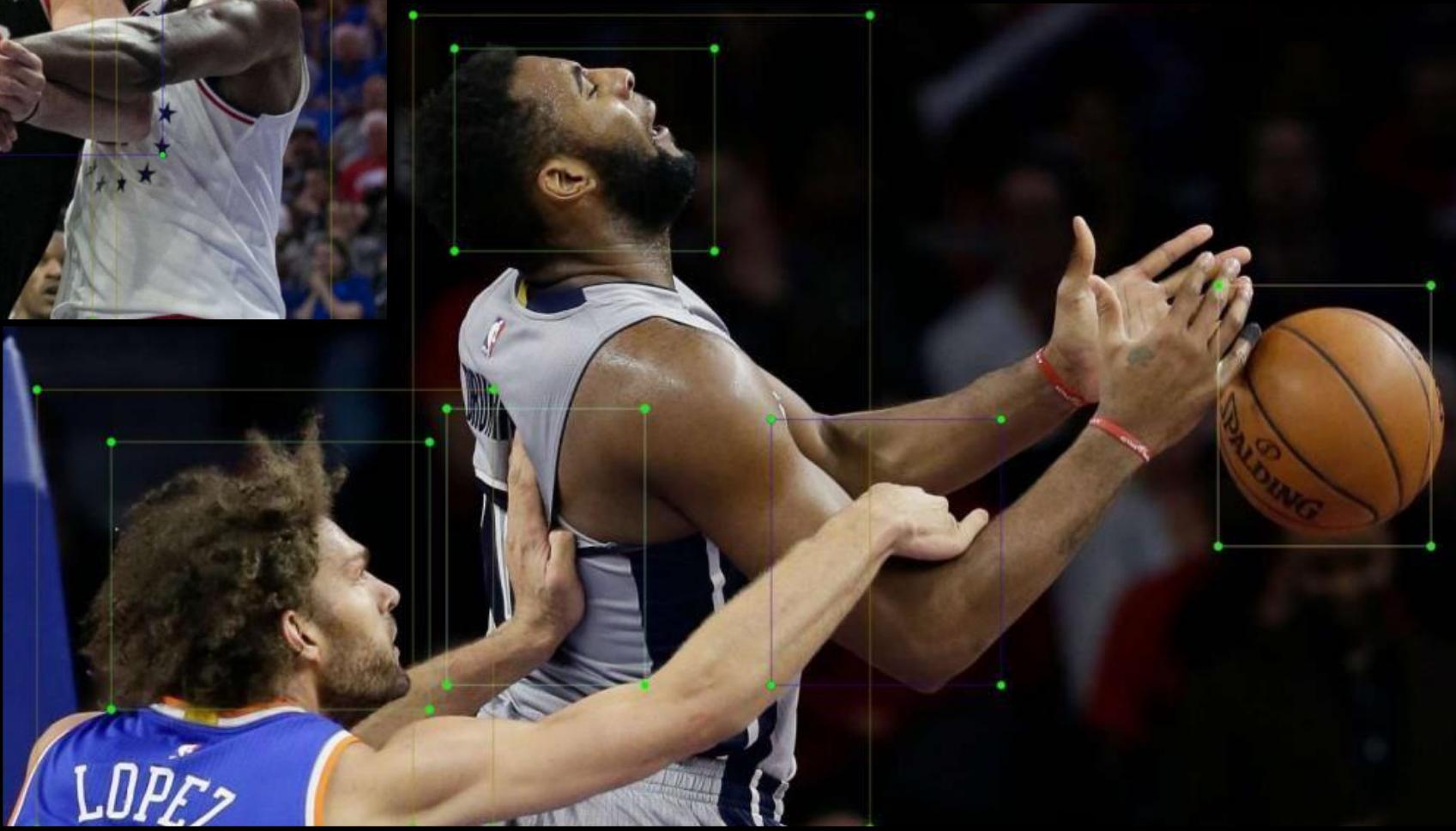


metrics/mAP_0.5:0.95





$$Loss = \lambda_1 L_{cls} + \lambda_2 L_{obj} + \lambda_3 L_{loc}$$



Fouls

Fouls Type	Foul Class
Personal Foul	0
Technical Foul	1
Flagrant Foul	2
Offensive Foul	3
Defensive Foul	4

30FPS

Unix
Epoch

A	B	C	D	E
1	Video File	Unix Epoch	Video Frame	Video Time Stamp
2	NBA_12th_Spring.mp4	1681657857	5490	00:03:05
3	NBA_12th_Spring.mp4	1672657385	10410	00:05:47
4	NBA_04th_Summer.mp4	1682637254	960	00:00:32
5	NBA_04th_Summer.mp4	1682638464	43560	00:24:12
6	NBA_15th_July.mp4	1682657857	24270	00:13:29
7	NBA_41th_2017.mp4	1682653548	3480	00:01:56
8	NBA_41th_2017.mp4	1682624377	13720	00:07:39
9	NBA_05th_2021.mp4	1682653417	7290	00:04:03
10				

Thank Ya!