

Traffic Sign Recognition & Realtime Detection

Traffic Sign Image Classification:

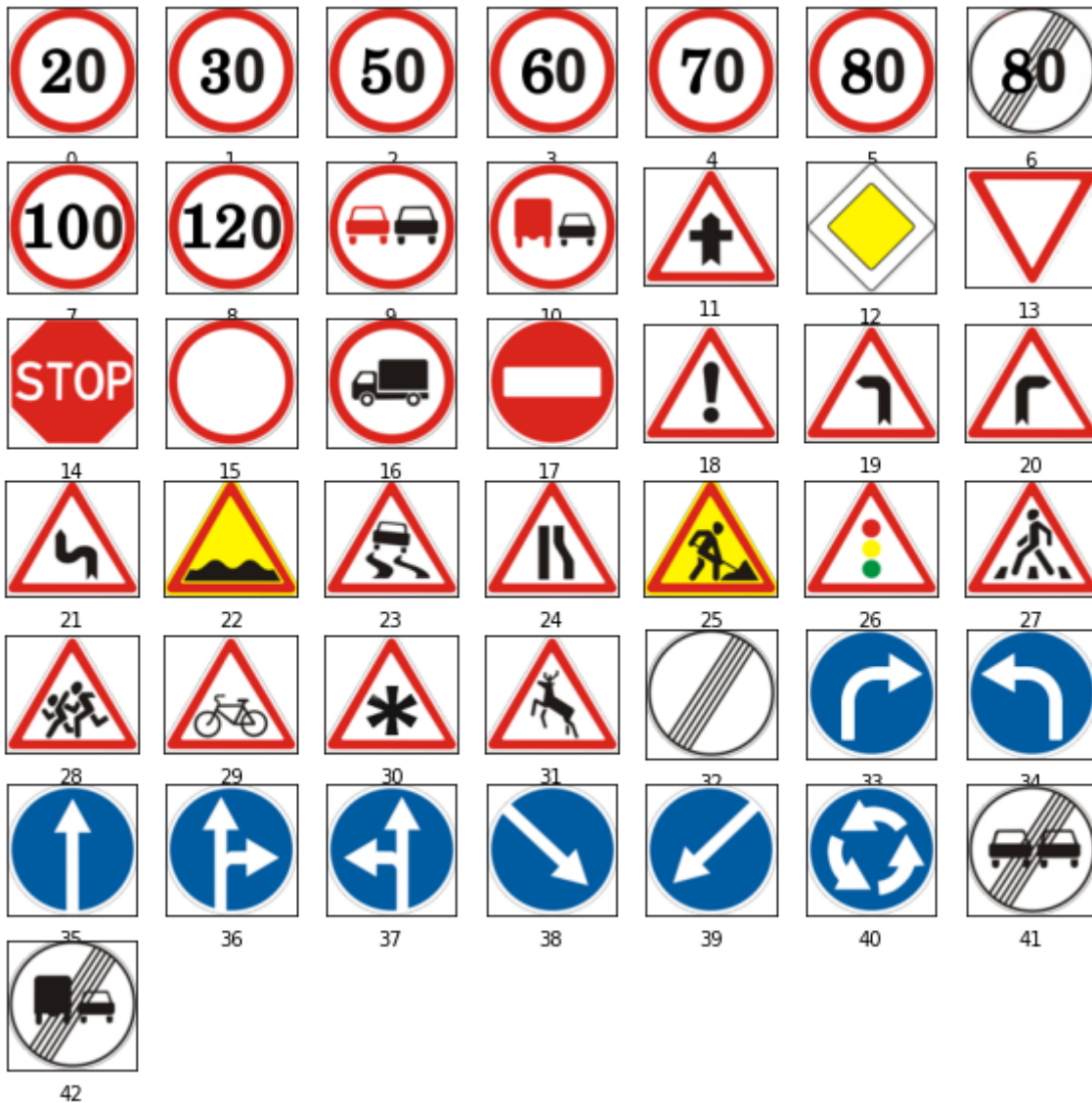
Dataset used for Traffic Sign Recognition:

- https://benchmark.ini.rub.de/gtsrb_news.html

Summary of the dataset:

- More than 40 classes in the dataset
 - Speed limit (20km/h)
 - Speed limit (30km/h)
 - Speed limit (50km/h)
 - Speed limit (60km/h)
 - Speed limit (70km/h)
 - Speed limit (80km/h)
 - End of speed limit (80km/h)
 - Speed limit (100km/h)
 - Speed limit (120km/h)
 - No passing
 - No passing veh over 3.5 tons
 - Right-of-way at intersection
 - Priority road
 - Yield
 - Stop
 - No vehicles
 - Veh > 3.5 tons prohibited
 - No entry
 - General caution
 - Dangerous curve left
 - Dangerous curve right
 - Double curve
 - Bumpy road
 - Slippery road
 - Road narrows on the right
 - Road work
 - Traffic signals
 - Pedestrians
 - Children crossing
 - Bicycles crossing
 - Beware of ice/snow

- Wild animals crossing
- End speed + passing limits
- Turn right ahead
- Turn left ahead
- Ahead only
- Go straight or right
- Go straight or left
- Keep right
- Keep left
- Roundabout mandatory
- End of no passing
- End no passing veh > 3.5 tons



- More than 50,000 images in total

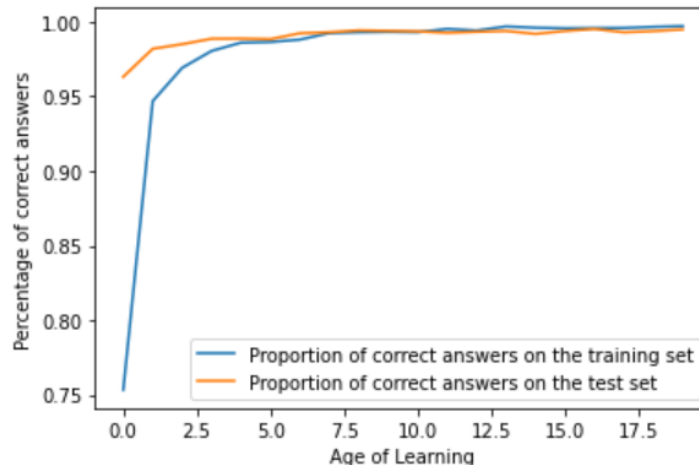
Training Steps:

- Split dataset into train & test set where 70% for training and 30% for testing
- Build an image classification model from scratch using TensorFlow Keras.
- Trainable params: 2,796,555

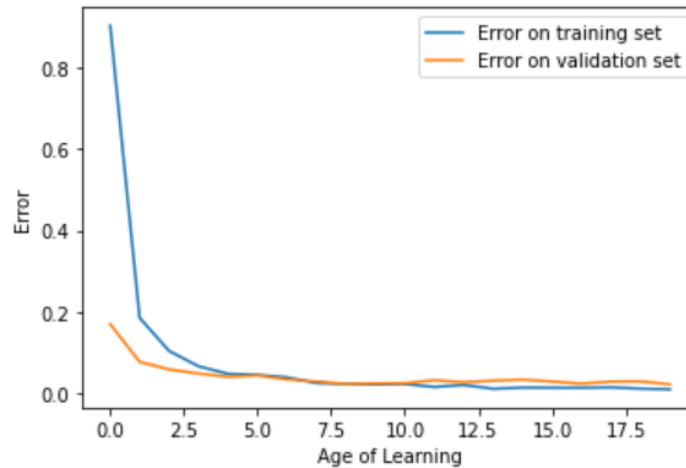
Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 28, 28, 16)	448
conv2d_1 (Conv2D)	(None, 26, 26, 32)	4640
max_pooling2d (MaxPooling2D)	(None, 13, 13, 32)	0
normalization (Normalization)	(None, 13, 13, 32)	65
flatten (Flatten)	(None, 5408)	0
dense (Dense)	(None, 512)	2769408
normalization_1 (Normalization)	(None, 512)	1025
dropout (Dropout)	(None, 512)	0
dense_1 (Dense)	(None, 43)	22059
Total params: 2,797,645		
Trainable params: 2,796,555		
Non-trainable params: 1,090		

- "categorical_crossentropy" loss & "Adam" optimizer used for training
- No of Epoch used: 20 & Batch Size 32
- Training Time (2min 10sec)
- Proportion of correct classification Graph



- Error on Training & Testing Graph



- Test accuracy: 97.015%

Traffic Sign Realtime Detection:

Dataset used for sign detection:

- https://benchmark.ini.rub.de/gtsdb_dataset.html

Summary of the dataset:

- 900 images (divided in 600 training images and 300 evaluation images)
- 4 Primary Categories:
 - **Prohibitory:** Prohibitory category consists of following Traffic Signs: speed limit, no overtaking, no traffic both ways, no trucks.
 - **Danger:** Danger category consists of following Traffic Signs: priority at next intersection, danger, bend left, bend right, bend, uneven road, slippery road, road narrows, construction, traffic signal, pedestrian crossing, school crossing, cycles crossing, snow, animals.
 - **Mandatory:** Mandatory category consists of following Traffic Signs: go right, go left, go straight, go right or straight, go left or straight, keep right, keep left, roundabout.
 - **Other:** Other category consists of following Traffic Signs: restriction ends, priority road, give way, stop, no entry.

Training Steps:

- YOLO (You Only Look Once) Detection Framework is used for the detection
- Converted the dataset into YOLO format

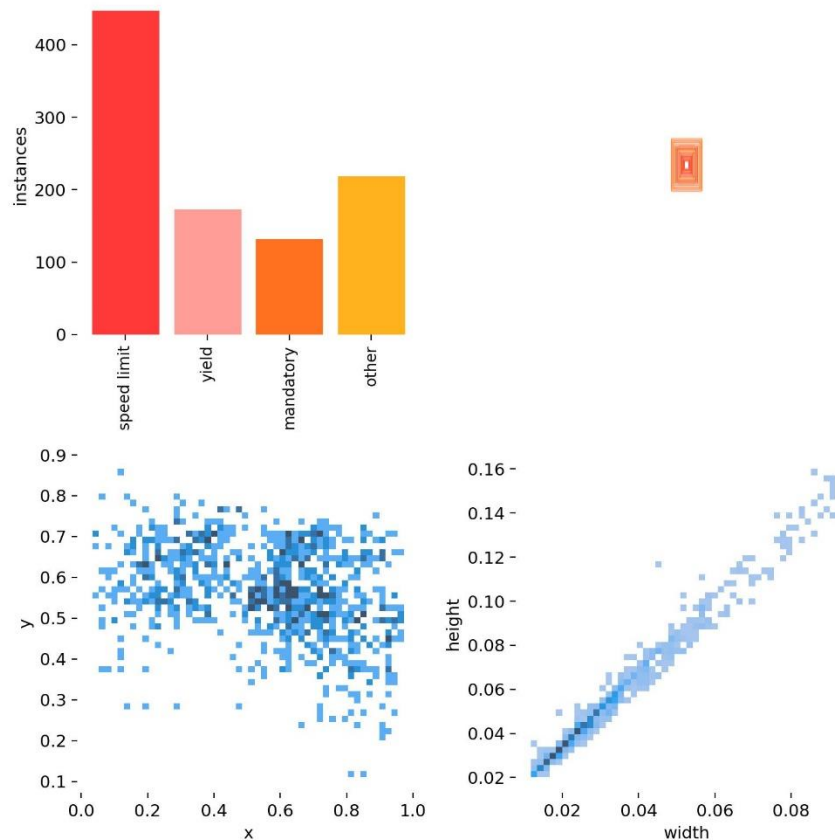
- YOLOv5s6 Model Architecture:

```
hyperparameters: lr=0.01, lrf=0.01, momentum=0.937, weight_decay=0.0005, warmup_epochs=3.0, warmup_momentum=0.8, warmup_bias_lr=0.1, box=0.05, cls=0.5, cls_pw=1.0, obj=1.0, obj_pw=1.0, iou_t=0.2, anchor_t=0.0, fl_gamma=0.0, hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, degrees=0.0, translate=0.1, scale=0.5, shear=0.0, perspective=0.0, flipud=0.0, fliplr=0.5, mosaic=1.0, mixup=0.0, copy_paste=0.0
TensorBoard: Start with 'tensorboard --logdir runs/train', view at http://localhost:6006/
wandb: wandb version 0.12.21 is available! To upgrade, please run:
wandb: $ pip install wandb --upgrade
wandb: Tracking run with wandb version 0.12.18
wandb: Run data is saved locally in c:\Users\polas\OneDrive\Documents\YOLOv5s6-Object-Detection-Projects\traffic-sign-detection\wandb\run-20220801-173738-1vuyhenf
wandb: Run 'wandb offline' to turn off syncing.
wandb: Syncing run morning-shape-18
wandb: View project at https://wandb.ai/ismailpolas/train
wandb: View run at https://wandb.ai/ismailpolas/train/runs/1vuyhenf
YOLOv5s temporarily requires wandb version 0.12.10 or below. Some features may not work as expected.
```

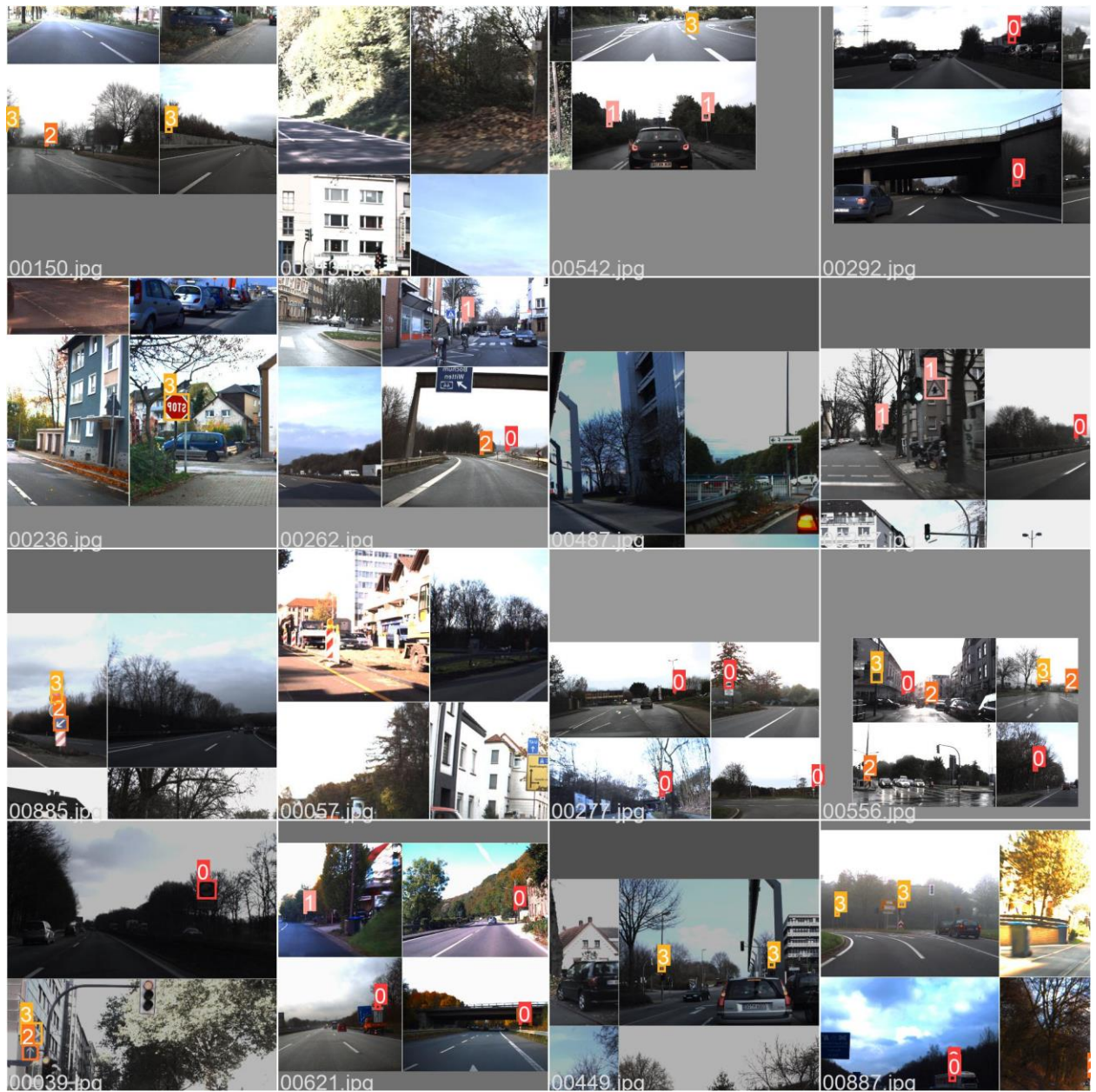
	from	n	params	module	arguments
0	-1	1	3520	models.common.Conv	[3, 32, 6, 2, 2]
1	-1	1	18560	models.common.Conv	[32, 64, 3, 2]
2	-1	1	18816	models.common.C3	[64, 64, 1]
3	-1	1	73984	models.common.Conv	[64, 128, 3, 2]
4	-1	2	115712	models.common.C3	[128, 128, 2]
5	-1	1	295024	models.common.Conv	[128, 256, 3, 2]
6	-1	3	625152	models.common.C3	[256, 256, 1]
7	-1	1	885504	models.common.Conv	[256, 384, 3, 2]
8	-1	1	665856	models.common.C3	[384, 384, 1]
9	-1	1	1778496	models.common.Conv	[384, 512, 3, 2]
10	-1	1	1127220	models.common.C3	[512, 512, 1]
11	-1	1	656896	models.common.SPPF	[512, 512, 5]
12	-1	1	197376	models.common.Conv	[512, 384, 1, 1]
13	-1	1	0	torch.nn.modules.upsampling.Upsample	[None, 2, 'nearest']
14	[-1, 8]	1	0	models.common.Concat	[1]
15	-1	1	813312	models.common.C3	[768, 384, 1, False]
16	-1	1	98816	models.common.Conv	[384, 256, 1, 1]
17	-1	1	0	torch.nn.modules.upsampling.Upsample	[None, 2, 'nearest']
18	[-1, 6]	1	0	models.common.Concat	[1]
19	-1	1	361984	models.common.C3	[512, 256, 1, False]
20	-1	1	33824	models.common.Conv	[256, 128, 1, 1]
21	-1	1	0	torch.nn.modules.upsampling.Upsample	[None, 2, 'nearest']
22	[-1, 4]	1	0	models.common.Concat	[1]
23	-1	1	98880	models.common.C3	[256, 128, 1, False]
24	-1	1	147712	models.common.Conv	[128, 128, 3, 2]
25	[-1, 20]	1	0	models.common.Concat	[1]
26	-1	1	296448	models.common.C3	[256, 256, 1, False]
27	-1	1	598336	models.common.Conv	[256, 256, 3, 2]
28	[-1, 16]	1	0	models.common.Concat	[1]
29	-1	1	715008	models.common.C3	[512, 384, 1, False]
30	-1	1	1327872	models.common.Conv	[384, 384, 3, 2]
31	[-1, 12]	1	0	models.common.Concat	[1]
32	-1	1	1313792	models.common.C3	[768, 512, 1, False]
33	[23, 26, 29, 32]	1	34668	models.yolo.Detect	[4, [[19, 27, 44, 40, 38, 94], [96, 68, 86, 152, 180, 137], [140, 381, 303, 264, 238, 542], [436, 615, 739, 380, 925, 792]], [128, 256, 384, 512]]

YOLOv5s_custom summary: 355 layers, 12333868 parameters, 12333868 gradients

- Image size: 1280x1280
- Batch Size: 16
- Labels Summary:



- **GROUND TRUTH AUGMENTED TRAINING DATA:**



- **Total No of Epochs:** 200
- **Hyperparameters:** lr0=0.01, lrf=0.01, momentum=0.937, weight_decay=0.0005, warmup_epochs=3.0, warmup_momentum=0.8, warmup_bias_lr=0.1, box=0.05, cls=0.5, cls_pw=1.0, obj=1.0, obj_pw=1.0, iou_t=0.2, anchor_t=4.0, fl_gamma=0.0, hsv_h=0.015, hsv_s=0.7, hsv_v=0.4, degrees=0.0, translate=0.1, scale=0.5, shear=0.0, perspective=0.0, flipud=0.0, fliplr=0.5, mosaic=1.0, mixup=0.0, copy_paste=0.0
- **Average time for per epoch training:** 23 sec

- **Total time of Training: 2.179 hrs.**

```

Epoch  gpu_mem  box    obj    cls  labels  img_size
191/199  11.7G  0.005937  0.002785  0.0004933  43  1280: 100%| 37/37 [00:38<00:00, 1.03s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.34it/s]
all     75      128     0.976  1      0.995     0.877

Epoch  gpu_mem  box    obj    cls  labels  img_size
192/199  11.7G  0.006679  0.002877  0.0007525  46  1280: 100%| 37/37 [00:38<00:00, 1.03s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.36it/s]
all     75      128     0.98  1      0.995     0.876

Epoch  gpu_mem  box    obj    cls  labels  img_size
193/199  11.7G  0.005981  0.002695  0.0003715  28  1280: 100%| 37/37 [00:38<00:00, 1.03s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.35it/s]
all     75      128     0.978  1      0.995     0.874

Epoch  gpu_mem  box    obj    cls  labels  img_size
194/199  11.7G  0.006251  0.002655  0.0004633  41  1280: 100%| 37/37 [00:38<00:00, 1.03s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.28it/s]
all     75      128     0.979  1      0.995     0.874

Epoch  gpu_mem  box    obj    cls  labels  img_size
195/199  11.7G  0.005817  0.002892  0.0004088  34  1280: 100%| 37/37 [00:37<00:00, 1.02s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.29it/s]
all     75      128     0.98  1      0.995     0.879

Epoch  gpu_mem  box    obj    cls  labels  img_size
196/199  11.7G  0.006433  0.002737  0.0008412  56  1280: 100%| 37/37 [00:38<00:00, 1.04s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.26it/s]
all     75      128     0.978  1      0.995     0.871

Epoch  gpu_mem  box    obj    cls  labels  img_size
197/199  11.7G  0.006032  0.002858  0.0003691  53  1280: 100%| 37/37 [00:37<00:00, 1.03s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.24it/s]
all     75      128     0.974  1      0.995     0.871

Epoch  gpu_mem  box    obj    cls  labels  img_size
198/199  11.7G  0.005937  0.002795  0.0003249  43  1280: 100%| 37/37 [00:38<00:00, 1.04s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:01<00:00, 2.30it/s]
all     75      128     0.975  1      0.995     0.877

Epoch  gpu_mem  box    obj    cls  labels  img_size
199/199  11.7G  0.005631  0.00293  0.000335  34  1280: 100%| 37/37 [00:38<00:00, 1.03s/it]
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:06<00:00, 2.29s/it]
all     75      128     0.978  1      0.995     0.873

200 epochs completed in 2.179 hours.
Optimizer stripped from runs\train\exp\weights\last.pt, 25.5MB
Optimizer stripped from runs\train\exp\weights\best.pt, 25.5MB

```

- **Training Summary:**

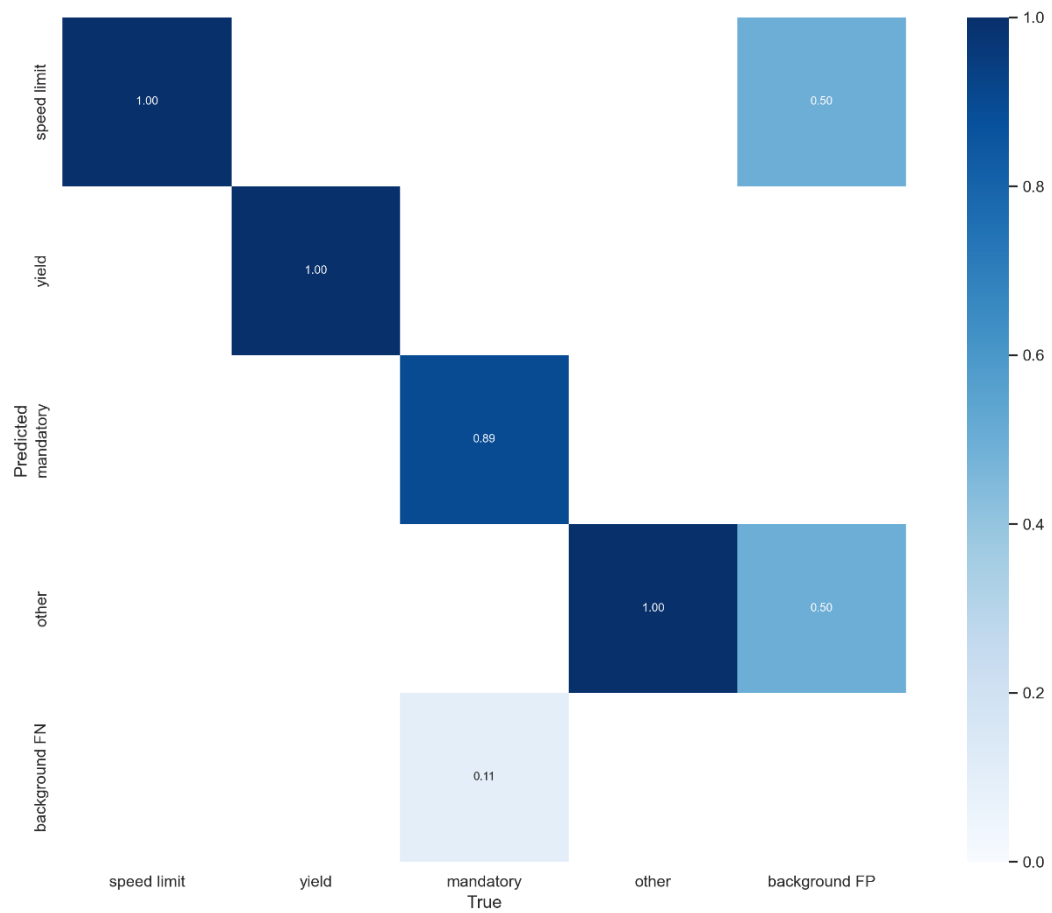
```

YOLOv5s_custom summary: 280 layers, 12319756 parameters, 0 gradients
Class   Images  Labels  P      R      mAP@.5  mAP@.5:.95: 100%| 3/3 [00:07<00:00, 2.52s/it]
all     75      128     0.968  1      0.995     0.879
speed limit 75      57     0.968  1      0.995     0.91
yield     75      26     0.97  1      0.995     0.871
mandatory 75      19      1      1      0.995     0.853
other     75      26     0.936  1      0.995     0.882

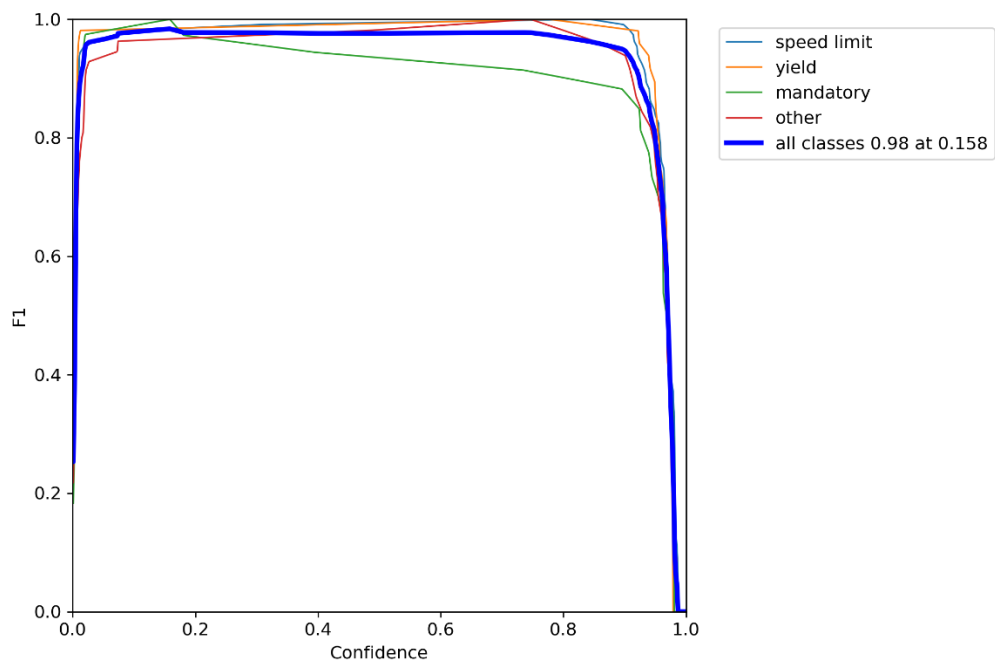
Results saved to runs\train\exp
wandb: Waiting for W&B process to finish... (success).
wandb:
wandb: Run history:
wandb: metrics/mAP_0.5
wandb: metrics/mAP_0.5:0.95
wandb: metrics/precision
wandb: metrics/recall
wandb: train/box_loss
wandb: train/cls_loss
wandb: train/obj_loss
wandb: val/box_loss
wandb: val/cls_loss
wandb: val/obj_loss
wandb: x/lr0
wandb: x/lr1
wandb: x/lr2
wandb:
wandb: Run summary:
wandb: best/epoch 185
wandb: best/mAP_0.5 0.995
wandb: best/mAP_0.5:0.95 0.87993
wandb: best/precision 0.96833
wandb: best/recall 0.99999
wandb: metrics/mAP_0.5 0.995
wandb: metrics/mAP_0.5:0.95 0.87912
wandb: metrics/precision 0.96841
wandb: metrics/recall 1.0
wandb: train/box_loss 0.00563
wandb: train/cls_loss 0.00034
wandb: train/obj_loss 0.00293
wandb: val/box_loss 0.00695
wandb: val/cls_loss 0.0003
wandb: val/obj_loss 0.00333
wandb: x/lr0 0.0002
wandb: x/lr1 0.0002
wandb: x/lr2 0.0002
wandb:
wandb: Synced morning-shape-18: https://wandb.ai/ismailpolas/train/runs/ivuyhmnf
wandb: Synced 5 W&B file(s), 337 media file(s), 1 artifact file(s) and 0 other file(s)
wandb: Find logs at: .\wandb\run-20220801_173738-ivuyhmnf\logs

```

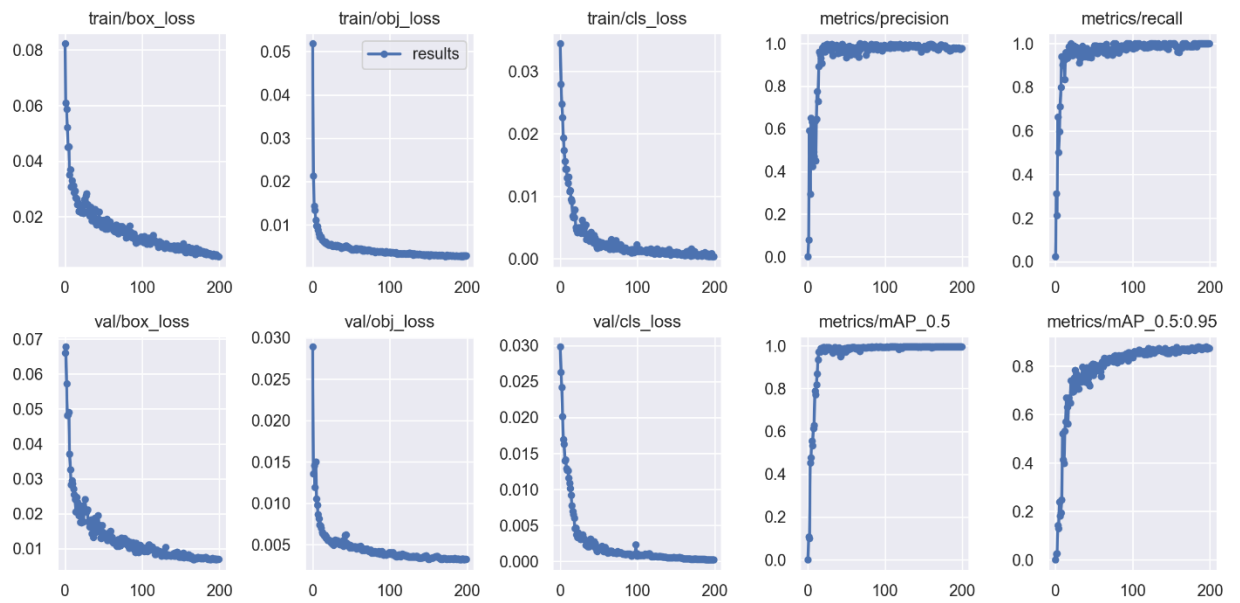
- **Confusion Matrix:**



- **F1-Curve:**



- Training Result:



- Testing Result:

