In [1]:
```
# Import required libraries
import pandas as pd
import numpy as np
import os
import glob
from datetime import datetime
import xml.etree.ElementTree as ET
import cv2
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

```
/opt/conda/lib/python3.10/site-packages/scipy/__init__.py:146: UserWarning:
A NumPy version >=1.16.5 and <1.23.0 is required for this version of SciPy
(detected version 1.23.5
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

In [2]:
```
!git clone https://github.com/ultralytics/yolov5
%cd yolov5
!pip install -qr requirements.txt
```

```
Cloning into 'yolov5'...
remote: Enumerating objects: 15994, done.
remote: Counting objects: 100% (27/27), done.
remote: Compressing objects: 100% (15/15), done.
remote: Total 15994 (delta 18), reused 18 (delta 12), pack-reused 15967
Receiving objects: 100% (15994/15994), 14.58 MiB | 13.15 MiB/s, done.
Resolving deltas: 100% (10984/10984), done.
/kaggle/working/yolov5
```

In [3]:
```
input_data = '/kaggle/input/face-mask-detection'
```

In [4]:
```
output_data = '/kaggle/working'
```

In [5]:
```
annotations_path = "/kaggle/input/face-mask-detection/annotations"
```

In [6]:
```
images_path = "/kaggle/input/face-mask-detection/images"
```

In [7]:
```
dataset = {
            "file":[],
            "name":[],
            "width":[],
            "height":[],
            "xmin":[],
            "ymin":[],
            "xmax":[],
            "ymax":[],
           }

for anno in glob.glob(annotations_path+"/*.xml"):
    tree = ET.parse(anno)

    for elem in tree.iter():
        if 'size' in elem.tag:
            for attr in list(elem):
                if 'width' in attr.tag:
                    width = int(round(float(attr.text)))
                if 'height' in attr.tag:
                    height = int(round(float(attr.text)))

        if 'object' in elem.tag:
            for attr in list(elem):

                if 'name' in attr.tag:
                    name = attr.text
                    dataset['name']+=[name]
                    dataset['width']+=[width]
                    dataset['height']+=[height]
                    dataset['file']+=[anno.split('/')[-1][0:-4]]

                if 'bndbox' in attr.tag:
                    for dim in list(attr):
                        if 'xmin' in dim.tag:
                            xmin = int(round(float(dim.text)))
                            dataset['xmin']+=[xmin]
                        if 'ymin' in dim.tag:
                            ymin = int(round(float(dim.text)))
                            dataset['ymin']+=[ymin]
                        if 'xmax' in dim.tag:
                            xmax = int(round(float(dim.text)))
                            dataset['xmax']+=[xmax]
                        if 'ymax' in dim.tag:
                            ymax = int(round(float(dim.text)))
                            dataset['ymax']+=[ymax]
```

In [8]:
```
df=pd.DataFrame(dataset)
df.head()
```

Out[8]:

| | file | name | width | height | xmin | ymin | xmax | ymax |
|---|---|---|---|---|---|---|---|---|
| 0 | maksssksksss737 | with_mask | 400 | 226 | 28 | 55 | 46 | 71 |
| 1 | maksssksksss737 | with_mask | 400 | 226 | 98 | 62 | 111 | 78 |
| 2 | maksssksksss737 | mask_weared_incorrect | 400 | 226 | 159 | 50 | 193 | 90 |
| 3 | maksssksksss737 | with_mask | 400 | 226 | 293 | 59 | 313 | 80 |
| 4 | maksssksksss737 | with_mask | 400 | 226 | 352 | 51 | 372 | 72 |

In [9]:
```
name_dict = {
    'with_mask': 0,
    'mask_weared_incorrect': 1,
    'without_mask': 2
}

df['class'] = df['name'].map(name_dict)
```

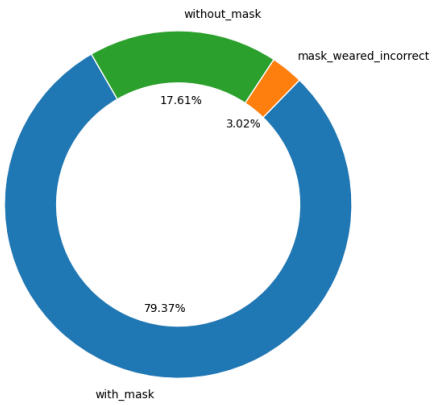
In [10]:
```
np.sort(df.name.unique())
```

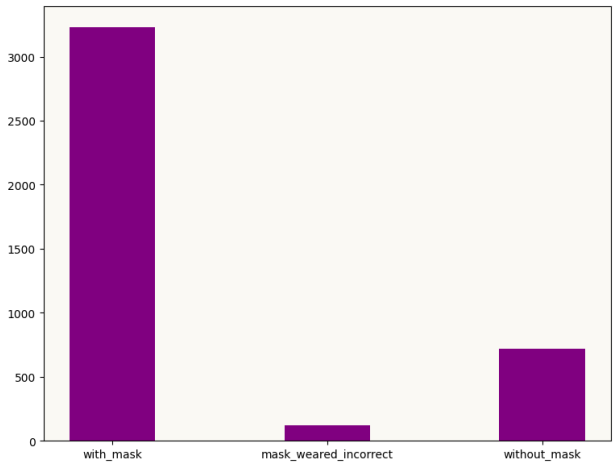
Out[10]:
```
array(['mask_weared_incorrect', 'with_mask', 'without_mask'], dtype=object)
```

In [11]:
```
labels = df.name.unique()
labels_list = [df['name'].value_counts()["with_mask"], df['name'].value_cour
print(labels_list)
print(labels)
```

```
[3232, 123, 717]
['with_mask' 'mask_weared_incorrect' 'without_mask']
```

In [12]:
```
fig, (ax1, ax2) = plt.subplots(1, 2, figsize =(20,7))
background_color = '#faf9f4'
ax1.set_facecolor(background_color)
ax2.set_facecolor(background_color)
ax1.pie(labels_list, wedgeprops=dict(width=0.3, edgecolor='w'),
        labels=labels, radius=1, startangle=120, autopct='%1.2f%%')

ax2 = plt.bar(labels, list(labels_list),
              color ='purple',width = 0.4)

plt.show()
```



In [13]:
```
fileNames = [*os.listdir("/kaggle/input/face-mask-detection/images")]
print('There are {} images in the dataset'.format(len(fileNames)))
```

```
There are 853 images in the dataset
```

In [14]:
```
from sklearn.model_selection import train_test_split
train, test = train_test_split(fileNames, test_size=0.1, random_state=22)
test, val = train_test_split(test, test_size=0.7, random_state=22)
print("Length of Train =",len(train))
print("="*30)
print("Length of Valid =",len(val))
print("="*30)
print("Length of test =", len(test))
```

```
Length of Train = 767
==============================
Length of Valid = 61
==============================
Length of test = 25
```

In [15]:
```
os.chdir('/kaggle/working/')
os.mkdir('./yolov5/data/train')
os.mkdir('./yolov5/data/val')
os.mkdir('./yolov5/data/test')
os.mkdir('./yolov5/data/train/images')
os.mkdir('./yolov5/data/train/labels')
os.mkdir('./yolov5/data/test/images')
os.mkdir('./yolov5/data/test/labels')
os.mkdir('./yolov5/data/val/images')
os.mkdir('./yolov5/data/val/labels')
```

In [16]:
```
from PIL import Image

def copyImages(imageList, folder_Name):
    for image in imageList:
        img = Image.open(input_data+"/images/"+image)
        img1 = img.resize((640, 480))
        _ = img1.save(output_data+"/yolov5/data/"+folder_Name+"/images/"+ima

copyImages(train, "train")
copyImages(val, "val")
copyImages(test, "test")
```

In [17]:
```
df['xmax'] = (640/df['width'])*df['xmax']
df['ymax'] = (480/df['height'])*df['ymax']
df['xmin'] = (640/df['width'])*df['xmin']
df['ymin'] = (480/df['height'])*df['ymin']
```

In [18]:
```
df['x_center'] = (df['xmax']+df['xmin'])/(2*640)
df['y_center'] = (df['ymax']+df['ymin'])/(2*480)
df['box_height'] = (df['xmax']-df['xmin'])/(640)
df['box_width'] = (df['ymax']-df['ymin'])/(480)
```

In [19]:
```
df = df.astype('string')
```

In [20]:
```
def create_labels(image_list, data_name):
    fileNames = [x.split(".")[0] for x in image_list]

    for name in fileNames:
        data = df[df.file==name]
        box_list = []

        for index in range(len(data)):
            row = data.iloc[index]
            box_list.append(row['class']+" "+row["x_center"]+" "+row["y_cent
                        +" "+row["box_height"]+" "+row["box_width"])

        text = "\n".join(box_list)
        with open(output_data+"/yolov5/data/"+data_name+"/labels/"+name+".tx
            file.write(text)


create_labels(train, "train")
create_labels(val, "val")
create_labels(test, "test")
```

In [21]:
```
%cd yolov5
from IPython.display import Image, clear_output
import torch
from yolov5 import utils
display = utils.notebook_init()
```

```
YOLOv5 🚀 v7.0-224-g6262c7f Python-3.10.12 torch-2.0.0 CUDA:0 (Tesla P100-P
CIE-16GB, 16281MiB)
Setup complete ✅ (2 CPUs, 15.6 GB RAM, 5016.7/8062.4 GB disk)
```

In [22]:
```
yaml_text = """train: data/train/images
val: data/train/images

nc: 3
names: ['with_mask', 'mask_weared_incorrect', 'without_mask']"""

with open("data/data.yaml", 'w') as file:
    file.write(yaml_text)

%cat data/data.yaml
```

```
train: data/train/images
val: data/train/images

nc: 3
names: ['with_mask', 'mask_weared_incorrect', 'without_mask']
```

In [23]:
```
# Customize iPython writefile for writing variables
from IPython.core.magic import register_line_cell_magic

@register_line_cell_magic
def writetemplate(line, cell):
    with open(line, 'w') as f:
        f.write(cell.format(**globals()))
```

In [24]:
```
%%writetemplate models/custom_yolov5s.yaml

# parameters
nc: 3  # number of classes
depth_multiple: 0.33  # model depth multiple
width_multiple: 0.50  # layer channel multiple

# anchors
anchors:
    - [10,13, 16,30, 33,23]  # P3/8
    - [30,61, 62,45, 59,119]  # P4/16
    - [116,90, 156,198, 373,326]  # P5/32

# YOLOv5 backbone
backbone:
  # [from, number, module, args]
  [[-1, 1, Focus, [64, 3]],  # 0-P1/2
   [-1, 1, Conv, [128, 3, 2]],  # 1-P2/4
   [-1, 3, BottleneckCSP, [128]],
   [-1, 1, Conv, [256, 3, 2]],  # 3-P3/8
   [-1, 9, BottleneckCSP, [256]],
   [-1, 1, Conv, [512, 3, 2]],  # 5-P4/16
   [-1, 9, BottleneckCSP, [512]],
   [-1, 1, Conv, [1024, 3, 2]],  # 7-P5/32
   [-1, 1, SPP, [1024, [5, 9, 13]]],
   [-1, 3, BottleneckCSP, [1024, False]],  # 9
  ]

# YOLOv5 head
head:
    [[-1, 1, Conv, [512, 1, 1]],
    [-1, 1, nn.Upsample, [None, 2, 'nearest']],
    [[-1, 6], 1, Concat, [1]],  # cat backbone P4
    [-1, 3, BottleneckCSP, [512, False]],  # 13

    [-1, 1, Conv, [256, 1, 1]],
    [-1, 1, nn.Upsample, [None, 2, 'nearest']],
    [[-1, 4], 1, Concat, [1]],  # cat backbone P3
    [-1, 3, BottleneckCSP, [256, False]],  # 17 (P3/8-small)

    [-1, 1, Conv, [256, 3, 2]],
    [[-1, 14], 1, Concat, [1]],  # cat head P4
    [-1, 3, BottleneckCSP, [512, False]],  # 20 (P4/16-medium)

    [-1, 1, Conv, [512, 3, 2]],
    [[-1, 10], 1, Concat, [1]],  # cat head P5
    [-1, 3, BottleneckCSP, [1024, False]],  # 23 (P5/32-large)

    [[17, 20, 23], 1, Detect, [nc, anchors]],  # Detect(P3, P4, P5)
    ]
```

In [25]:
```
start = datetime.now()
!python train.py --img 640 --batch 32 --epochs 50 --data data/data.yaml --cf
end = datetime.now()
```

```
WARNING ⚠️ invalid check_version(3.1.31, ) requested, please check values.
train: weights=yolov5s.pt, cfg=models/custom_yolov5s.yaml, data=data/data.y
aml, hyp=data/hyps/hyp.scratch-low.yaml, epochs=50, batch_size=32, imgsz=64
0, rect=False, resume=False, nosave=False, noval=False, noautoanchor=False,
noplots=False, evolve=None, bucket=, cache=ram, image_weights=False, device
=, multi_scale=False, single_cls=False, optimizer=SGD, sync_bn=False, worke
rs=8, project=runs/train, name=yolov5s_results, exist_ok=False, quad=False,
cos_lr=False, label_smoothing=0.0, patience=100, freeze=[0], save_period=-
1, seed=0, local_rank=-1, entity=None, upload_dataset=False, bbox_interval=
-1, artifact_alias=latest
github: up to date with https://github.com/ultralytics/yolov5 ✅
WARNING ⚠️ invalid check_version(5.9.5, ) requested, please check values.
YOLOv5 🚀 v7.0-224-g6262c7f Python-3.10.12 torch-2.0.0 CUDA:0 (Tesla P100-P
CIE-16GB, 16281MiB)

hyperparameters: lr0=0.01, lrf=0.01, momentum=0.937, weight_decay=0.0005, w
armup_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, s
hear=0.0, perspective=0.0, flipud=0.0, fliplr=0.5, mosaic=1.0, mixup=0.0, c
opy_paste=0.0
Comet: run 'pip install comet_ml' to automatically track and visualize YOLO
v5 🚀 runs in Comet
TensorBoard: Start with 'tensorboard --logdir runs/train', view at http://l
ocalhost:6006/
Downloading https://github.com/ultralytics/yolov5/releases/download/v7.0/yo
lov5s.pt to yolov5s.pt...
100%|████████████████████████████████████████| 14.1M/14.1M [00:00<00:00, 173
MB/s]


                 from  n    params  module
arguments
  0                -1  1      3520  models.common.Focus
[3, 32, 3]
  1                -1  1     18560  models.common.Conv
[32, 64, 3, 2]
  2                -1  1     19904  models.common.BottleneckCSP
[64, 64, 1]
  3                -1  1     73984  models.common.Conv
[64, 128, 3, 2]
  4                -1  3    161152  models.common.BottleneckCSP
[128, 128, 3]
  5                -1  1    295424  models.common.Conv
[128, 256, 3, 2]
  6                -1  3    641792  models.common.BottleneckCSP
[256, 256, 3]
  7                -1  1   1180672  models.common.Conv
[256, 512, 3, 2]
  8                -1  1    656896  models.common.SPP
[512, 512, [5, 9, 13]]
  9                -1  1   1248768  models.common.BottleneckCSP
[512, 512, 1, False]
 10                -1  1    131584  models.common.Conv
[512, 256, 1, 1]
 11                -1  1         0  torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']
 12           [-1, 6]  1         0  models.common.Concat
[1]
```

```
 13                -1  1    378624  models.common.BottleneckCSP
[512, 256, 1, False]
 14                -1  1     33024  models.common.Conv
[256, 128, 1, 1]
 15                -1  1         0  torch.nn.modules.upsampling.Upsample
[None, 2, 'nearest']
 16           [-1, 4]  1         0  models.common.Concat
[1]
 17                -1  1     95104  models.common.BottleneckCSP
[256, 128, 1, False]
 18                -1  1    147712  models.common.Conv
[128, 128, 3, 2]
 19          [-1, 14]  1         0  models.common.Concat
[1]
 20                -1  1    313088  models.common.BottleneckCSP
[256, 256, 1, False]
 21                -1  1    590336  models.common.Conv
[256, 256, 3, 2]
 22          [-1, 10]  1         0  models.common.Concat
[1]
 23                -1  1   1248768  models.common.BottleneckCSP
[512, 512, 1, False]
 24      [17, 20, 23]  1     21576  models.yolo.Detect
[3, [[10, 13, 16, 30, 33, 23], [30, 61, 62, 45, 59, 119], [116, 90, 156, 19
8, 373, 326]], [128, 256, 512]]
custom_YOLOv5s summary: 233 layers, 7260488 parameters, 7260488 gradients

Transferred 223/369 items from yolov5s.pt
AMP: checks passed ✅
optimizer: SGD(lr=0.01) with parameter groups 59 weight(decay=0.0), 70 weig
ht(decay=0.0005), 62 bias
albumentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01, blur_li
mit=(3, 7)), ToGray(p=0.01), CLAHE(p=0.01, clip_limit=(1, 4.0), tile_grid_s
ize=(8, 8))
train: Scanning /kaggle/working/yolov5/data/train/labels... 767 images, 0 b
ackgr
train: New cache created: /kaggle/working/yolov5/data/train/labels.cache
train: Caching images (0.1GB ram):  17%|█▋        | 129/767 [00:01<00:08, 7
6.63ilibpng warning: iCCP: Not recognizing known sRGB profile that has been
edited
train: Caching images (0.7GB ram): 100%|██████████| 767/767 [00:10<00:00, 7
5.83i
val: Scanning /kaggle/working/yolov5/data/train/labels.cache... 767 images,
0 ba
val: Caching images (0.3GB ram):  52%|█████     | 396/767 [00:06<00:04, 75.
37it/libpng warning: iCCP: Not recognizing known sRGB profile that has been
edited
val: Caching images (0.7GB ram): 100%|██████████| 767/767 [00:11<00:00, 65.
12it/

AutoAnchor: 5.66 anchors/target, 0.999 Best Possible Recall (BPR). Current
anchors are a good fit to dataset ✅
Plotting labels to runs/train/yolov5s_results/labels.jpg...
Image sizes 640 train, 640 val
Using 2 dataloader workers
Logging results to runs/train/yolov5s_results
Starting training for 50 epochs...

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
```

```
ze
       0/49      7.83G     0.1062    0.06427    0.03557        296        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650   0.000748     0.0591    0.000
46   0.000119

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       1/49      7.83G     0.0951    0.07114    0.02986        211        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650   0.000666     0.0527   0.0004
11   0.000112

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       2/49      7.83G    0.08738    0.07262     0.0233        218        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650   0.000619     0.0489   0.0004
46   0.000115

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       3/49      7.83G    0.08087    0.06514    0.02023        261        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650    0.00253      0.166    0.005
13    0.00144

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       4/49      7.83G    0.07618     0.0596    0.01768        316        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.763     0.0921     0.06
52     0.0226

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       5/49      7.83G    0.06956    0.05571    0.01743        234        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.787      0.124
0.1     0.0397

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       6/49      7.83G    0.06349    0.05206    0.01817        285        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
```

```
                 all        767       3650        0.8      0.188       0.1
52     0.0559

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       7/49      7.83G    0.06066    0.04855     0.0169        271        6
40: 1
                Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.852      0.207      0.2
28     0.0962

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       8/49      7.83G    0.05565    0.05029    0.01578        192        6
40: 1
                Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.863       0.23      0.2
82      0.113

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
       9/49      7.83G    0.05314    0.04418    0.01509        204        6
40: 1
                Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.679       0.38      0.3
74      0.154

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      10/49      7.83G     0.0525    0.04349    0.01426        280        6
40: 1
                Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.691      0.409      0.4
08      0.161

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      11/49      7.83G    0.05055    0.04324    0.01274        201        6
40: 1
                Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.787      0.391      0.4
28      0.166

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      12/49      7.83G    0.04817    0.04238    0.01117        197        6
40: 1
                Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.768      0.431      0.4
72      0.207

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
```

```
      13/49      7.83G    0.04831    0.04345    0.01102        205        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.858      0.466      0.5
26      0.251

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      14/49      7.83G    0.04635    0.04059   0.009693        236        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650       0.84      0.451      0.5
04      0.246

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      15/49      7.83G    0.04454    0.04075     0.0091        207        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650       0.88      0.449      0.5
39      0.279

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      16/49      7.83G    0.04458    0.04079   0.009346        199        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650       0.89       0.48      0.5
73       0.29

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      17/49      7.83G    0.04354    0.04018   0.008952        222        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.861      0.477       0.
56      0.283

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      18/49      7.83G    0.04268       0.04    0.00848        219        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.896      0.493      0.6
16      0.314

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      19/49      7.83G    0.04154     0.0368    0.00827        258        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.889      0.495      0.6
```

```
07      0.317

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      20/49      7.83G    0.04062    0.03701   0.008281        220        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.888      0.495      0.6
03      0.319

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      21/49      7.83G    0.03983    0.03638   0.008555        169        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.862      0.496      0.6
07      0.326

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      22/49      7.83G    0.03952    0.03642   0.007434        196        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.894      0.504      0.5
86      0.317

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      23/49      7.83G    0.03904    0.03705   0.007864        196        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.907      0.528      0.6
19      0.333

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      24/49      7.83G    0.03819    0.03703   0.007761        265        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.891      0.514      0.6
03      0.336

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      25/49      7.83G    0.03724    0.03665   0.007299        219        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.904      0.507      0.6
22      0.357

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      26/49      7.83G     0.0371    0.03622   0.007698        233        6
```

```
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.898      0.527      0.6
34      0.361

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      27/49      7.83G    0.03695    0.03845   0.007553        264        6
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.913      0.534      0.6
61      0.378

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      28/49      7.83G     0.0366     0.0355   0.006999        239        6
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.917      0.526      0.6
76      0.389

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      29/49      7.83G    0.03549    0.03472   0.006836        250        6
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.912      0.523      0.6
42      0.361

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      30/49      7.83G    0.03499    0.03367   0.006699        192        6
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.903      0.533      0.6
21      0.359

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      31/49      7.83G    0.03487    0.03573   0.006753        252        6
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650      0.909      0.547      0.6
78      0.403

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      32/49      7.83G    0.03498    0.03465   0.006885        294        6
40: 1
               Class     Images  Instances          P          R      mAP
50
                 all        767       3650       0.92      0.546      0.6
76        0.4
```

```
      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      33/49      7.83G    0.03389    0.03316   0.006297        311        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.915      0.555      0.6
99      0.417

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      34/49      7.83G    0.03302    0.03391   0.006165        315        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.916      0.545      0.6
62      0.403

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      35/49      7.83G    0.03369    0.03283   0.006287        239        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.622      0.682      0.7
03      0.433

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      36/49      7.83G    0.03303    0.03324   0.006188        219        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.941      0.544      0.6
94      0.433

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      37/49      7.83G     0.0332    0.03491   0.006124        281        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650       0.94      0.557      0.6
72      0.407

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      38/49      7.83G     0.0324    0.03211   0.005959        204        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.582      0.685      0.7
13      0.446

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      39/49      7.83G    0.03216    0.03106   0.006064        261        6
40: 1
```

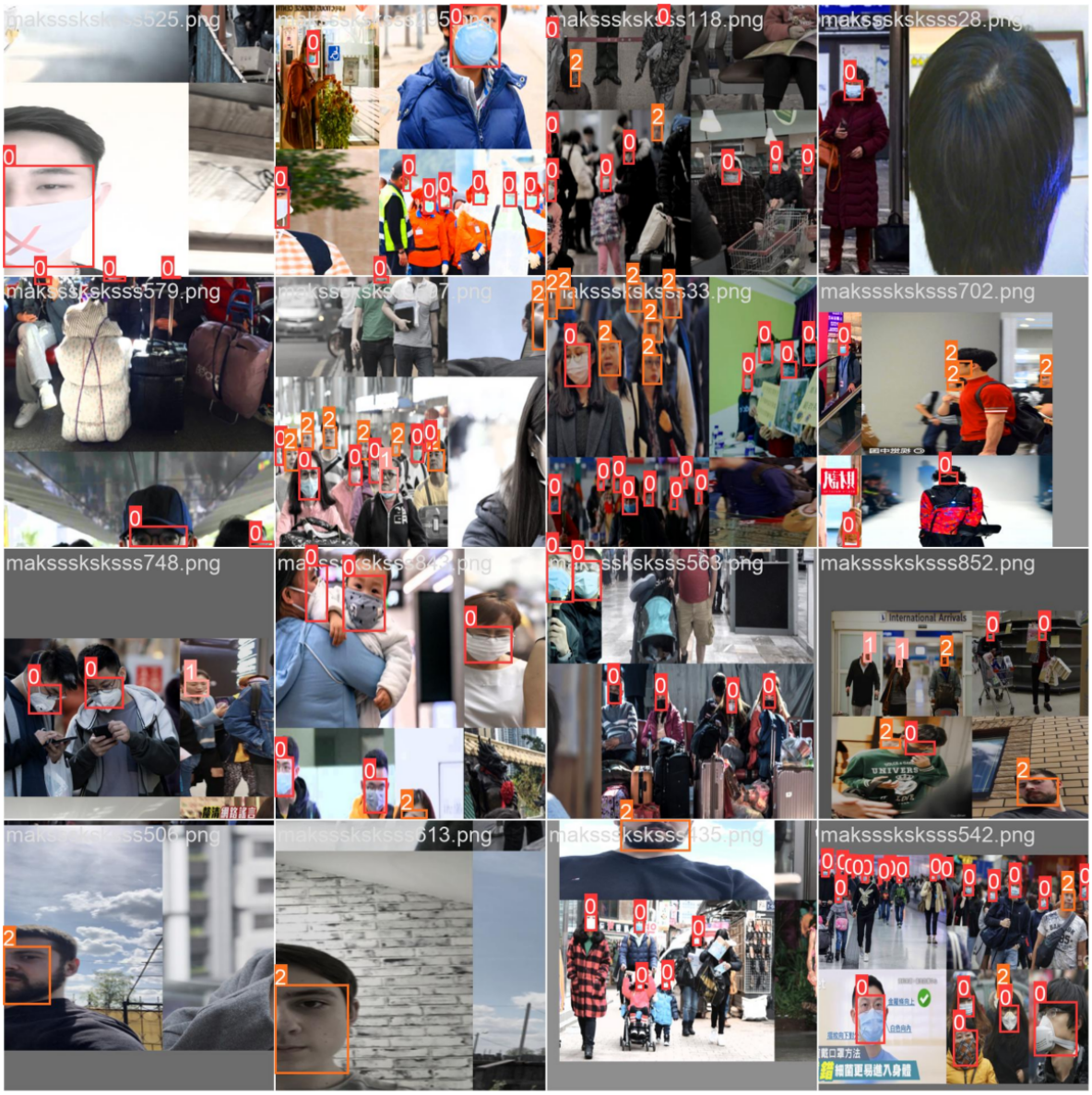
```
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650       0.63      0.724      0.7
37      0.467

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      40/49      7.83G    0.03098    0.03222   0.005405        183        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.583       0.66      0.6
91      0.436

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      41/49      7.83G    0.03147    0.03236   0.005858        229        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.597      0.678      0.7
13       0.45

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      42/49      7.83G    0.03182    0.03281    0.00608        325        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.671      0.719      0.7
56      0.483

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      43/49      7.83G    0.03003    0.03055    0.00517        241        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.601      0.695      0.7
33      0.472

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      44/49      7.83G      0.031    0.03291     0.0059        225        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.643      0.738      0.7
67      0.497

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      45/49      7.83G    0.03106    0.03376   0.005378        386        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.587      0.709      0.7
35      0.473
```

```
      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      46/49      7.83G    0.03017    0.03169   0.005146        227        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.615      0.719      0.7
41      0.482

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      47/49      7.83G    0.02927    0.03034   0.004997        263        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.668      0.733      0.7
69      0.504

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      48/49      7.83G    0.03037    0.03084   0.005805        223        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.622      0.717       0.
76      0.495

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Si
ze
      49/49      7.83G    0.03008    0.03135   0.004765        209        6
40: 1
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.644      0.727      0.7
66      0.503

50 epochs completed in 0.279 hours.
Optimizer stripped from runs/train/yolov5s_results/weights/last.pt, 14.9MB
Optimizer stripped from runs/train/yolov5s_results/weights/best.pt, 14.9MB

Validating runs/train/yolov5s_results/weights/best.pt...
Fusing layers...
custom_YOLOv5s summary: 182 layers, 7251912 parameters, 0 gradients
                 Class     Images  Instances          P          R      mAP
50
                   all        767       3650      0.673      0.735      0.7
69      0.504
              with_mask        767       2911      0.798      0.962      0.9
68       0.66
 mask_weared_incorrect        767        112      0.648      0.328      0.4
55      0.323
            without_mask        767        627      0.572      0.914      0.8
83       0.53
Results saved to runs/train/yolov5s_results
```

In [26]:
```
print("Runtime =",end-start)
```

```
Runtime = 0:18:04.920269
```

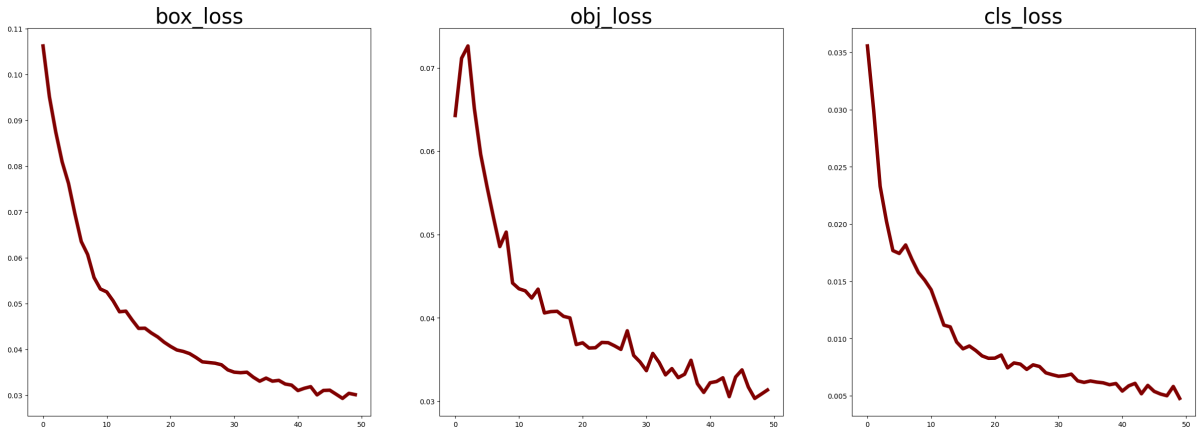
In [27]:
```
img = plt.imread('runs/train/yolov5s_results/train_batch2.jpg')
plt.figure(figsize=(30,15))
plt.imshow(img)
plt.axis('off')
plt.show()
```



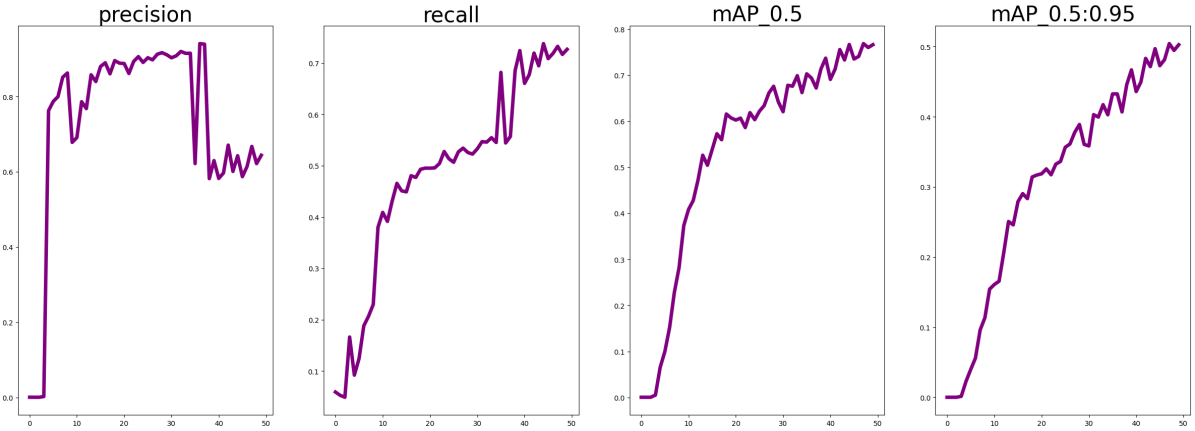

In [ ]:

In [28]:
```
results_df = pd.read_csv("/kaggle/working/yolov5/runs/train/yolov5s_results/
columns_list = []

for name in results_df.columns:
    if name == '               epoch':
        continue
    else:
        columns_list.append(results_df[name].tolist())

def plot_graphs_yolov5(values, titles, color):
    plt.figure(figsize = (30, 10))

    for i, title in enumerate(titles):
        plt.subplot(1, len(titles), i + 1)
        plt.plot(values[i], linewidth=5, color=color)
        plt.title(title, size=30)

    plt.show()
```

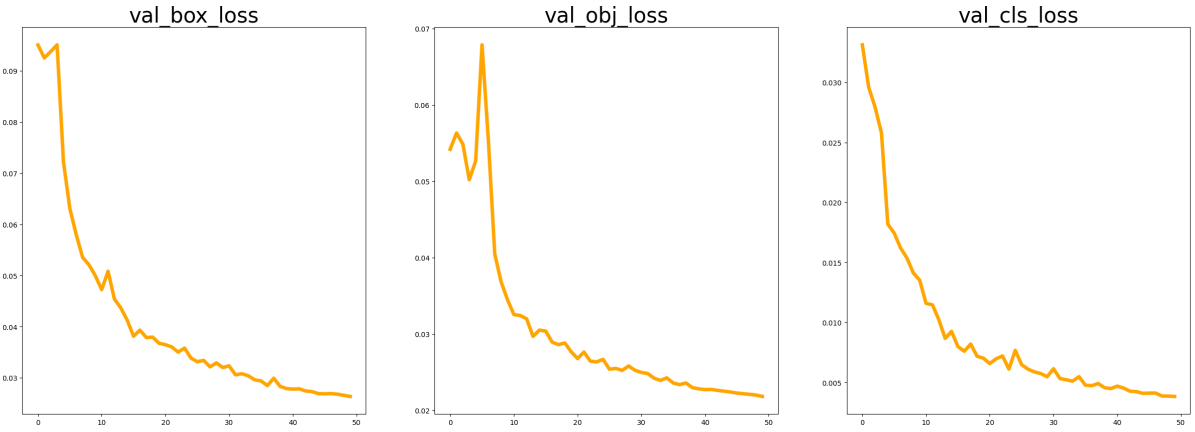
In [29]:
```
losses = columns_list[:3]

titles = ['box_loss', 'obj_loss', 'cls_loss']

plot_graphs_yolov5(losses, titles, 'maroon')
```



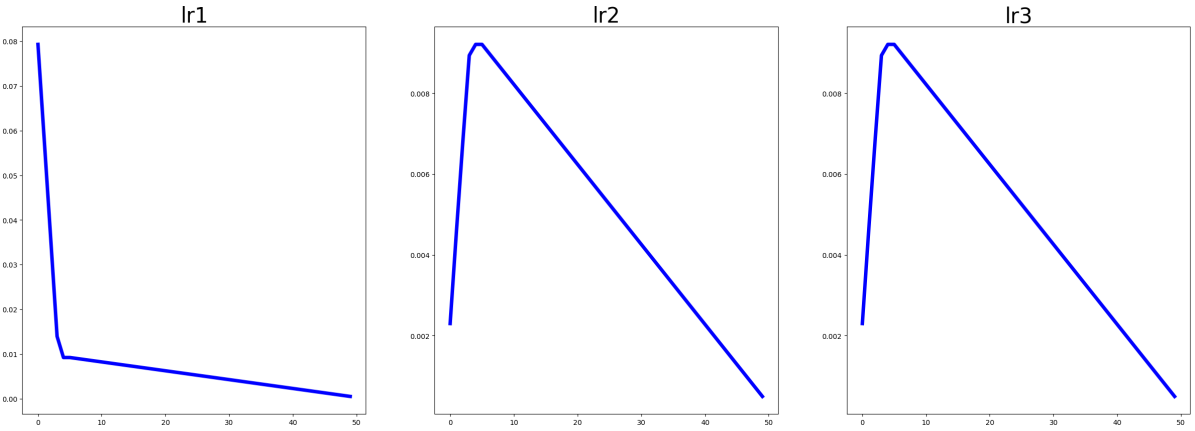

In [30]:
```
metrics = columns_list[3:7]

titles = ['precision', 'recall', 'mAP_0.5', 'mAP_0.5:0.95']

plot_graphs_yolov5(metrics, titles, 'purple')
```




In [31]:
```
validation = columns_list[7:10]

titles = ['val_box_loss', 'val_obj_loss', 'val_cls_loss']

plot_graphs_yolov5(validation, titles, 'orange')
```




In [32]:
```
learning_rates = columns_list[10:13]

titles = ['lr1', 'lr2', 'lr3']

plot_graphs_yolov5(learning_rates, titles, 'blue')
```




In [33]:
```
!python detect.py --source data/test/images/ --weight runs/train/yolov5s_res
```

```
detect: weights=['runs/train/yolov5s_results/weights/best.pt'], source=data
/test/images/, data=data/coco128.yaml, imgsz=[640, 640], conf_thres=0.4, io
u_thres=0.45, max_det=1000, device=, view_img=False, save_txt=False, save_c
sv=False, save_conf=False, save_crop=False, nosave=False, classes=None, agn
ostic_nms=False, augment=False, visualize=False, update=False, project=runs
/detect, name=expTestImage, exist_ok=False, line_thickness=3, hide_labels=F
alse, hide_conf=False, half=False, dnn=False, vid_stride=1
WARNING ⚠️ invalid check_version(5.9.5, ) requested, please check values.
YOLOv5 🚀 v7.0-224-g6262c7f Python-3.10.12 torch-2.0.0 CUDA:0 (Tesla P100-P
CIE-16GB, 16281MiB)

Fusing layers...
custom_YOLOv5s summary: 182 layers, 7251912 parameters, 0 gradients
image 1/25 /kaggle/working/yolov5/data/test/images/maksssksksss151.png: 480
x640 9 with_masks, 46.6ms
image 2/25 /kaggle/working/yolov5/data/test/images/maksssksksss164.png: 480
x640 6 with_masks, 3 without_masks, 7.0ms
image 3/25 /kaggle/working/yolov5/data/test/images/maksssksksss173.png: 480
x640 3 with_masks, 6.5ms
image 4/25 /kaggle/working/yolov5/data/test/images/maksssksksss193.png: 480
x640 3 with_masks, 6.8ms
image 5/25 /kaggle/working/yolov5/data/test/images/maksssksksss236.png: 480
x640 1 without_mask, 6.8ms
image 6/25 /kaggle/working/yolov5/data/test/images/maksssksksss24.png: 480x
640 (no detections), 8.2ms
image 7/25 /kaggle/working/yolov5/data/test/images/maksssksksss323.png: 480
x640 1 with_mask, 7.0ms
image 8/25 /kaggle/working/yolov5/data/test/images/maksssksksss381.png: 480
x640 4 with_masks, 6.5ms
image 9/25 /kaggle/working/yolov5/data/test/images/maksssksksss433.png: 480
x640 1 with_mask, 6.5ms
image 10/25 /kaggle/working/yolov5/data/test/images/maksssksksss466.png: 48
0x640 4 with_masks, 6.6ms
image 11/25 /kaggle/working/yolov5/data/test/images/maksssksksss497.png: 48
0x640 1 with_mask, 6.6ms
image 12/25 /kaggle/working/yolov5/data/test/images/maksssksksss607.png: 48
0x640 2 with_masks, 7.9ms
image 13/25 /kaggle/working/yolov5/data/test/images/maksssksksss611.png: 48
0x640 5 with_masks, 7.2ms
image 14/25 /kaggle/working/yolov5/data/test/images/maksssksksss630.png: 48
0x640 1 with_mask, 6.6ms
image 15/25 /kaggle/working/yolov5/data/test/images/maksssksksss640.png: 48
0x640 9 with_masks, 6.4ms
image 16/25 /kaggle/working/yolov5/data/test/images/maksssksksss65.png: 480
x640 2 with_masks, 6.7ms
image 17/25 /kaggle/working/yolov5/data/test/images/maksssksksss658.png: 48
0x640 (no detections), 6.5ms
image 18/25 /kaggle/working/yolov5/data/test/images/maksssksksss747.png: 48
0x640 1 with_mask, 8.5ms
image 19/25 /kaggle/working/yolov5/data/test/images/maksssksksss750.png: 48
0x640 7 without_masks, 7.2ms
image 20/25 /kaggle/working/yolov5/data/test/images/maksssksksss755.png: 48
0x640 5 with_masks, 7.4ms
image 21/25 /kaggle/working/yolov5/data/test/images/maksssksksss770.png: 48
0x640 4 with_masks, 2 without_masks, 6.7ms
image 22/25 /kaggle/working/yolov5/data/test/images/maksssksksss772.png: 48
0x640 2 without_masks, 6.7ms
image 23/25 /kaggle/working/yolov5/data/test/images/maksssksksss796.png: 48
0x640 13 with_masks, 6.6ms
```

```
image 24/25 /kaggle/working/yolov5/data/test/images/maksssksksss797.png: 48
0x640 6 with_masks, 6.6ms
image 25/25 /kaggle/working/yolov5/data/test/images/maksssksksss848.png: 48
0x640 3 with_masks, 7.1ms
Speed: 0.5ms pre-process, 8.5ms inference, 1.0ms NMS per image at shape (1,
3, 640, 640)
Results saved to runs/detect/expTestImage
```

In [34]:
```
color_dict = {
    'with_mask': (0, 255, 0),
    'mask_weared_incorrect':  (0, 0, 255),
    'without_mask': (255, 0, 0)
}
```

In [35]:
```
def show_image(img_id):
    df_image = df[df.file==img_id]
    df_image[['xmin', 'ymin', 'xmax', 'ymax']] = df_image[['xmin', 'ymin', '
    path = 'data/test/images/'+img_id# +'.png'
    img = plt.imread(path)

    imge = img.copy()

    for index in range(len(df_image)):
        row = df_image.iloc[index]
        cv2.rectangle(imge,
                      (row['xmin'], row['ymin']),
                      (row['xmax'], row['ymax']),
                      color=color_dict[row['name']],
                      thickness=2)

    # results are saved inside run/detect/expTestImage dir
    img_pred = plt.imread('runs/detect/expTestImage/'+img_id)
    # ====================================
    plt.figure(figsize=(30,20))

    plt.subplot(1,2,1)
    plt.imshow(imge)
    plt.axis('off')
    plt.title('Test image')

    plt.subplot(1,2,2)
    plt.imshow(img_pred)
    plt.axis('off')
    plt.title('Image with Predicted Box')
```

In [36]:
```
import os, random
for i in range(5):
    show_image(random.choice(os.listdir("data/test/images/")))
    plt.show()
```

Test image

Image with Predicted Box


Test image

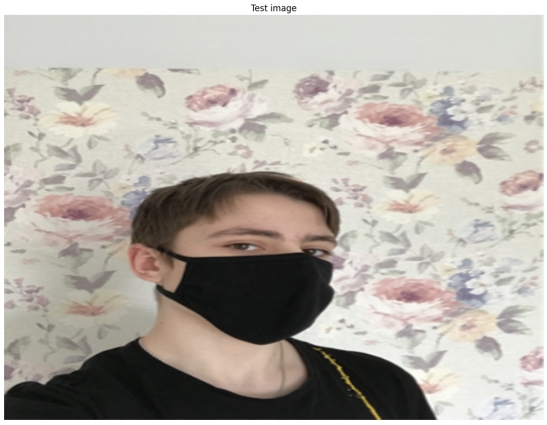
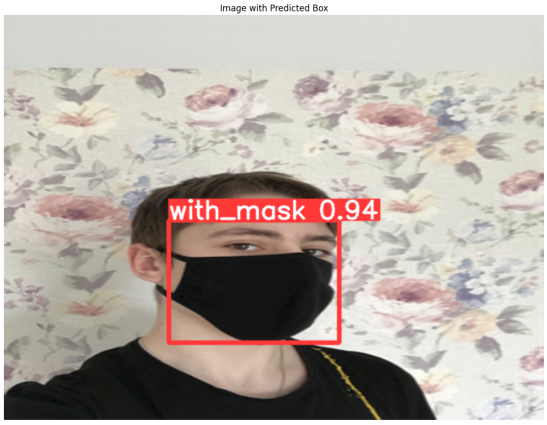


Image with Predicted Box




Test image

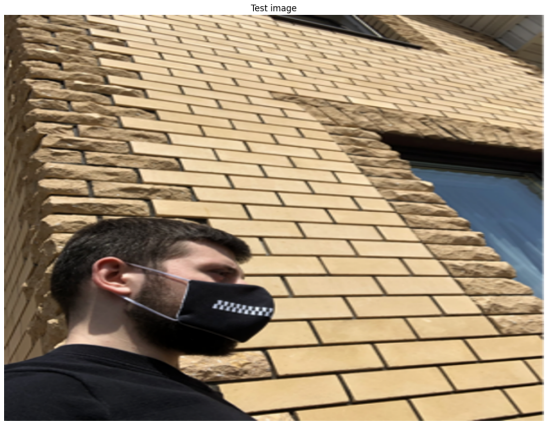
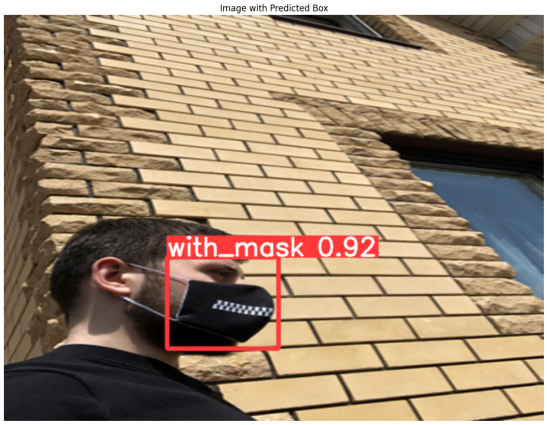


Image with Predicted Box




Test image

Image with Predicted Box


Test image


Image with Predicted Box
with_mask 0.94
with_mask 0.78

In [ ]: