Install Dependencies

(Remember to choose GPU in Runtime if not already selected. Runtime --> Change Runtime Type --> Hardware accelerator --> GPU)

```
!nvidia-smi
```

```
Sun Feb 16 18:57:25 2025
+-----------------------------------------------------------------------------------------+
| NVIDIA-SMI 550.54.15              Driver Version: 550.54.15      CUDA Version: 12.4     |
|-----------------------------------------+------------------------+----------------------+
| GPU  Name                 Persistence-M | Bus-Id          Disp.A | Volatile Uncorr. ECC |
| Fan  Temp   Perf          Pwr:Usage/Cap |           Memory-Usage | GPU-Util  Compute M. |
|                                         |                        |               MIG M. |
|=========================================+========================+======================|
|   0  Tesla T4                       Off |   00000000:00:04.0 Off |                    0 |
| N/A   55C    P8             10W /   70W |       0MiB /  15360MiB |      0%      Default |
|                                         |                        |                  N/A |
+-----------------------------------------+------------------------+----------------------+

+-----------------------------------------------------------------------------------------+
| Processes:                                                                              |
|  GPU   GI   CI        PID   Type   Process name                              GPU Memory |
|        ID   ID                                                               Usage      |
|=========================================================================================|
|  No running processes found                                                             |
+-----------------------------------------------------------------------------------------+
```

```
# clone YOLOv5 repository
!git clone https://github.com/ultralytics/yolov5.git  # clone repo
```

```
Cloning into 'yolov5'...
remote: Enumerating objects: 17270, done.
remote: Counting objects: 100% (1/1), done.
remote: Total 17270 (delta 0), reused 0 (delta 0), pack-reused 17269 (from 2)
Receiving objects: 100% (17270/17270), 16.12 MiB | 29.05 MiB/s, done.
Resolving deltas: 100% (11858/11858), done.
```

```
%cd yolov5
```

```
/content/yolov5
```

```
# install dependencies as necessary
!pip install -qr requirements.txt  # install dependencies (ignore errors)
import torch

from IPython.display import Image, clear_output  # to display images
# from utils.google_utils import gdrive_download  # to download models/datasets

# clear_output()
print('Setup complete. Using torch %s %s' % (torch.__version__, torch.cuda.get_device_properties(0) if torch.cuda.is_available() else '(
```

```
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 363.4/363.4 MB 4.3 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 13.8/13.8 MB 110.6 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 24.6/24.6 MB 87.3 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 883.7/883.7 kB 57.7 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 664.8/664.8 MB 1.3 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 211.5/211.5 MB 5.5 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 56.3/56.3 MB 11.6 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 127.9/127.9 MB 7.3 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 207.5/207.5 MB 5.7 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 21.1/21.1 MB 90.3 MB/s eta 0:00:00
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 914.9/914.9 kB 49.6 MB/s eta 0:00:00
Setup complete. Using torch 2.5.1+cu124 _CudaDeviceProperties(name='Tesla T4', major=7, minor=5, total_memory=15095MB, multi_process
```

Retrieve Custom Data

```
%cd /content
```

```
/content
```

```
%ls .
```

```
data.yaml  sample_data/  sign_data.zip  test/  train/  yolov5/
```

```
import gdown


# download the data from g drive

url = "https://drive.google.com/file/d/1hyqb2U1-Cz6qIs8ZY7aUhO-3y2MnSHId/view?usp=drive_link"
file_id = url.split("/")[-2]
print(file_id)

prefix = 'https://drive.google.com/uc?/export=download&id='
gdown.download(prefix+file_id, "sign_data.zip")
```

```
1hyqb2U1-Cz6qIs8ZY7aUhO-3y2MnSHId
Downloading...
From: https://drive.google.com/uc?/export=download&id=1hyqb2U1-Cz6qIs8ZY7aUhO-3y2MnSHId
To: /content/sign_data.zip
100%|██████████| 3.94M/3.94M [00:00<00:00, 244MB/s]
'sign_data.zip'
```

```
!unzip sign_data.zip -d /content/
!mv /content/sign_data/* /content/
!rm -r /content/sign_data /content/sign_data.zip /content/README.dataset.txt /content/README.roboflow.txt
```

```
  inflating: /content/train/labels/yes_fbd686d9-cb82-11ec-808a-04ea56e2f17f_jpg.rf.3c4a46ab94539b70e487b1f5666c85a0.txt
  inflating: /content/train/labels/yes_fd0df830-cb82-11ec-ae59-04ea56e2f17f_jpg.rf.c74a9523579ac3944ef7a8ab6751bff4.txt
  inflating: /content/train/labels/yes_fe4590e7-cb82-11ec-b9fa-04ea56e2f17f_jpg.rf.911f0435e6bd40ed41e133332285dffa.txt
   creating: /content/valid/
   creating: /content/valid/images/
 extracting: /content/valid/images/bathroom_9f37af2b-cc52-11ec-aebd-04ea56e2f17f_jpg.rf.0b862a33a98ec6698be673c883c37906.jpg
 extracting: /content/valid/images/bathroom_a40865d7-cc52-11ec-aef0-04ea56e2f17f_jpg.rf.6817c6e081da0c4bfa91b970cbf95734.jpg
 extracting: /content/valid/images/hello_c3a7ce9c-cb82-11ec-92bc-04ea56e2f17f_jpg.rf.ab20dcef52dc7495951646a925b29941.jpg
 extracting: /content/valid/images/hello_c74c9342-cb82-11ec-b9a4-04ea56e2f17f_jpg.rf.803dd94fc60f9a0c6f7ef392d767ece4.jpg
 extracting: /content/valid/images/help_43be3ea6-cc52-11ec-ae9e-04ea56e2f17f_jpg.rf.48afe99d6ed7fe94a63a3766d551c779.jpg
 extracting: /content/valid/images/help_4625771e-cc52-11ec-8b67-04ea56e2f17f_jpg.rf.9e0ec8a99c0cb48e13b998f023095bf6.jpg
 extracting: /content/valid/images/iloveyou_265f2c1f-cb83-11ec-b641-04ea56e2f17f_jpg.rf.14694625643f9012739f11c0b0886dc2.jpg
 extracting: /content/valid/images/iloveyou_279a851e-cb83-11ec-9383-04ea56e2f17f_jpg.rf.bb7b0452c5e1b0461e8528ef68d8f34d.jpg
 extracting: /content/valid/images/iloveyou_2c757801-cb83-11ec-95cc-04ea56e2f17f_jpg.rf.d1b8f488c4d6da00097580eb5da4fec1.jpg
 extracting: /content/valid/images/iloveyou_376605f5-cb83-11ec-bc56-04ea56e2f17f_jpg.rf.01a00d6717d07d98b6000e5676f9a781.jpg
 extracting: /content/valid/images/more_7f9eb438-cc52-11ec-aed5-04ea56e2f17f_jpg.rf.a60c42ed2d9f6d7decfed92c6e5a3088.jpg
 extracting: /content/valid/images/more_8ba41cfe-cc52-11ec-bd8d-04ea56e2f17f_jpg.rf.f3fa1abb1f9cdbf58141debfee46f090.jpg
 extracting: /content/valid/images/no_0e2aa3a7-cb83-11ec-8048-04ea56e2f17f_jpg.rf.faed9c51e6f32759aa70b7dd04a227b7.jpg
 extracting: /content/valid/images/no_17dcfbed-cb83-11ec-b71f-04ea56e2f17f_jpg.rf.b0dc8872bc7f621b22ea3f013d3cae52.jpg
 extracting: /content/valid/images/no_1b81a986-cb83-11ec-ae48-04ea56e2f17f_jpg.rf.eb1c3b482ca44ad50f2657582d97bfbc.jpg
 extracting: /content/valid/images/repeat_3dd5c381-cc53-11ec-84c5-04ea56e2f17f_jpg.rf.589ca7acb6b284a432dc8409201dd846.jpg
 extracting: /content/valid/images/repeat_42a439f1-cc53-11ec-84ff-04ea56e2f17f_jpg.rf.ff6c64dda9c5dc9f007f32c2dade5329.jpg
 extracting: /content/valid/images/repeat_43d9f419-cc53-11ec-9e2b-04ea56e2f17f_jpg.rf.e4f1a65d16c5dfdc27ac442c2ed7ffc8.jpg
 extracting: /content/valid/images/thanks_dc253246-cb82-11ec-ab38-04ea56e2f17f_jpg.rf.8999a72d124275132cc86c1202352fd8.jpg
 extracting: /content/valid/images/thanks_e10187f7-cb82-11ec-b6b4-04ea56e2f17f_jpg.rf.a9731a595bec567c7b5f0aeba00a937e.jpg
 extracting: /content/valid/images/thanks_e2391755-cb82-11ec-aec7-04ea56e2f17f_jpg.rf.45ca785d1b417c2e4cebd100d8bfb519.jpg
 extracting: /content/valid/images/thanks_e3704022-cb82-11ec-8d64-04ea56e2f17f_jpg.rf.3d1c4dfcf8167675a53da00e98fafcf8.jpg
 extracting: /content/valid/images/thanks_e4a5f778-cb82-11ec-bbdf-04ea56e2f17f_jpg.rf.3a8be978e3ab1565acc50f466cdd30df.jpg
 extracting: /content/valid/images/yes_01e89e18-cb83-11ec-8b48-04ea56e2f17f_jpg.rf.e361ef664eef580aaa36f5e72ffdca59.jpg
 extracting: /content/valid/images/yes_ff7bfcb1-cb82-11ec-bd32-04ea56e2f17f_jpg.rf.27981ddbca763b13d5abc42354e7e91a.jpg
   creating: /content/valid/labels/
  inflating: /content/valid/labels/bathroom_9f37af2b-cc52-11ec-aebd-04ea56e2f17f_jpg.rf.0b862a33a98ec6698be673c883c37906.txt
  inflating: /content/valid/labels/bathroom_a40865d7-cc52-11ec-aef0-04ea56e2f17f_jpg.rf.6817c6e081da0c4bfa91b970cbf95734.txt
  inflating: /content/valid/labels/hello_c3a7ce9c-cb82-11ec-92bc-04ea56e2f17f_jpg.rf.ab20dcef52dc7495951646a925b29941.txt
  inflating: /content/valid/labels/hello_c74c9342-cb82-11ec-b9a4-04ea56e2f17f_jpg.rf.803dd94fc60f9a0c6f7ef392d767ece4.txt
  inflating: /content/valid/labels/help_43be3ea6-cc52-11ec-ae9e-04ea56e2f17f_jpg.rf.48afe99d6ed7fe94a63a3766d551c779.txt
  inflating: /content/valid/labels/help_4625771e-cc52-11ec-8b67-04ea56e2f17f_jpg.rf.9e0ec8a99c0cb48e13b998f023095bf6.txt
  inflating: /content/valid/labels/iloveyou_265f2c1f-cb83-11ec-b641-04ea56e2f17f_jpg.rf.14694625643f9012739f11c0b0886dc2.txt
  inflating: /content/valid/labels/iloveyou_279a851e-cb83-11ec-9383-04ea56e2f17f_jpg.rf.bb7b0452c5e1b0461e8528ef68d8f34d.txt
  inflating: /content/valid/labels/iloveyou_2c757801-cb83-11ec-95cc-04ea56e2f17f_jpg.rf.d1b8f488c4d6da00097580eb5da4fec1.txt
  inflating: /content/valid/labels/iloveyou_376605f5-cb83-11ec-bc56-04ea56e2f17f_jpg.rf.01a00d6717d07d98b6000e5676f9a781.txt
  inflating: /content/valid/labels/more_7f9eb438-cc52-11ec-aed5-04ea56e2f17f_jpg.rf.a60c42ed2d9f6d7decfed92c6e5a3088.txt
  inflating: /content/valid/labels/more_8ba41cfe-cc52-11ec-bd8d-04ea56e2f17f_jpg.rf.f3fa1abb1f9cdbf58141debfee46f090.txt
  inflating: /content/valid/labels/no_0e2aa3a7-cb83-11ec-8048-04ea56e2f17f_jpg.rf.faed9c51e6f32759aa70b7dd04a227b7.txt
  inflating: /content/valid/labels/no_17dcfbed-cb83-11ec-b71f-04ea56e2f17f_jpg.rf.b0dc8872bc7f621b22ea3f013d3cae52.txt
  inflating: /content/valid/labels/no_1b81a986-cb83-11ec-ae48-04ea56e2f17f_jpg.rf.eb1c3b482ca44ad50f2657582d97bfbc.txt
  inflating: /content/valid/labels/repeat_3dd5c381-cc53-11ec-84c5-04ea56e2f17f_jpg.rf.589ca7acb6b284a432dc8409201dd846.txt
  inflating: /content/valid/labels/repeat_42a439f1-cc53-11ec-84ff-04ea56e2f17f_jpg.rf.ff6c64dda9c5dc9f007f32c2dade5329.txt
  inflating: /content/valid/labels/repeat_43d9f419-cc53-11ec-9e2b-04ea56e2f17f_jpg.rf.e4f1a65d16c5dfdc27ac442c2ed7ffc8.txt
 extracting: /content/valid/labels/thanks_dc253246-cb82-11ec-ab38-04ea56e2f17f_jpg.rf.8999a72d124275132cc86c1202352fd8.txt
 extracting: /content/valid/labels/thanks_e10187f7-cb82-11ec-b6b4-04ea56e2f17f_jpg.rf.a9731a595bec567c7b5f0aeba00a937e.txt
  inflating: /content/valid/labels/thanks_e2391755-cb82-11ec-aec7-04ea56e2f17f_jpg.rf.45ca785d1b417c2e4cebd100d8bfb519.txt
  inflating: /content/valid/labels/thanks_e3704022-cb82-11ec-8d64-04ea56e2f17f_jpg.rf.3d1c4dfcf8167675a53da00e98fafcf8.txt
  inflating: /content/valid/labels/thanks_e4a5f778-cb82-11ec-bbdf-04ea56e2f17f_jpg.rf.3a8be978e3ab1565acc50f466cdd30df.txt
  inflating: /content/valid/labels/yes_01e89e18-cb83-11ec-8b48-04ea56e2f17f_jpg.rf.e361ef664eef580aaa36f5e72ffdca59.txt
  inflating: /content/valid/labels/yes_ff7bfcb1-cb82-11ec-bd32-04ea56e2f17f_jpg.rf.27981ddbca763b13d5abc42354e7e91a.txt
mv: cannot stat '/content/sign_data/*': No such file or directory
rm: cannot remove '/content/sign_data': No such file or directory
```

```
%ls .
```

```
data.yaml  sample_data/  test/  train/  valid/  yolov5/
```

```
%cat data.yaml
```

```
train: ../train/images
val: ../valid/images
test: ../test/images

nc: 9
names: ['Bathroom', 'Hello', 'Help', 'ILoveYou', 'More', 'No', 'Repeat', 'Thanks', 'Yes']

roboflow:
  workspace: cv-jnrgc
  project: yolov5-demo
  version: 1
  license: CC BY 4.0
  url: https://universe.roboflow.com/cv-jnrgc/yolov5-demo/dataset/1
```

Define Model Configuration and Architecture

We will write a yaml script that defines the parameters for our model like the number of classes, anchors, and each layer.

You do not need to edit these cells, but you may.

```
# define number of classes based on YAML
import yaml
with open("data.yaml", 'r') as stream:
    num_classes = str(yaml.safe_load(stream)['nc'])
```

```
num_classes
```

```
'9'
```

```
#this is the model configuration we will use
%cat /content/yolov5/models/yolov5s.yaml
```

```
# Ultralytics 🚀 AGPL-3.0 License - https://ultralytics.com/license

# Parameters
nc: 80 # number of classes
depth_multiple: 0.33 # model depth multiple
width_multiple: 0.50 # layer channel multiple
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 v6.0 backbone
backbone:
  # [from, number, module, args]
  [
    [-1, 1, Conv, [64, 6, 2, 2]], # 0-P1/2
    [-1, 1, Conv, [128, 3, 2]], # 1-P2/4
    [-1, 3, C3, [128]],
    [-1, 1, Conv, [256, 3, 2]], # 3-P3/8
    [-1, 6, C3, [256]],
    [-1, 1, Conv, [512, 3, 2]], # 5-P4/16
    [-1, 9, C3, [512]],
    [-1, 1, Conv, [1024, 3, 2]], # 7-P5/32
    [-1, 3, C3, [1024]],
    [-1, 1, SPPF, [1024, 5]], # 9
  ]

# YOLOv5 v6.0 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, C3, [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, C3, [256, False]], # 17 (P3/8-small)

    [-1, 1, Conv, [256, 3, 2]],
    [[-1, 14], 1, Concat, [1]], # cat head P4
    [-1, 3, C3, [512, False]], # 20 (P4/16-medium)

    [-1, 1, Conv, [512, 3, 2]],
    [[-1, 10], 1, Concat, [1]], # cat head P5
    [-1, 3, C3, [1024, False]], # 23 (P5/32-large)

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

```
#customize iPython writefile so we can write 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()))
```

```
%%writetemplate /content/yolov5/models/custom_yolov5s.yaml

# parameters
nc: {num_classes}  # 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)
  ]
```

Train Custom YOLOv5 Detector

Next, we'll fire off training!

Here, we are able to pass a number of arguments:

- **img:** define input image size
- **batch:** determine batch size
- **epochs:** define the number of training epochs. (Note: often, 3000+ are common here!)
- **data:** set the path to our yaml file
- **cfg:** specify our model configuration
- **weights:** specify a custom path to weights. (Note: you can download weights from the Ultralytics Google Drive folder)
- **name:** result names
- **nosave:** only save the final checkpoint
- **cache:** cache images for faster training

```
# train yolov5s on custom data for 500 epochs
# time its performance
%%time
%cd /content/yolov5/
!python train.py --img 640 --batch 16 --epochs 500 --data '../data.yaml' --cfg ./models/custom_yolov5s.yaml --weights 'yolov5s.pt' --nar
```

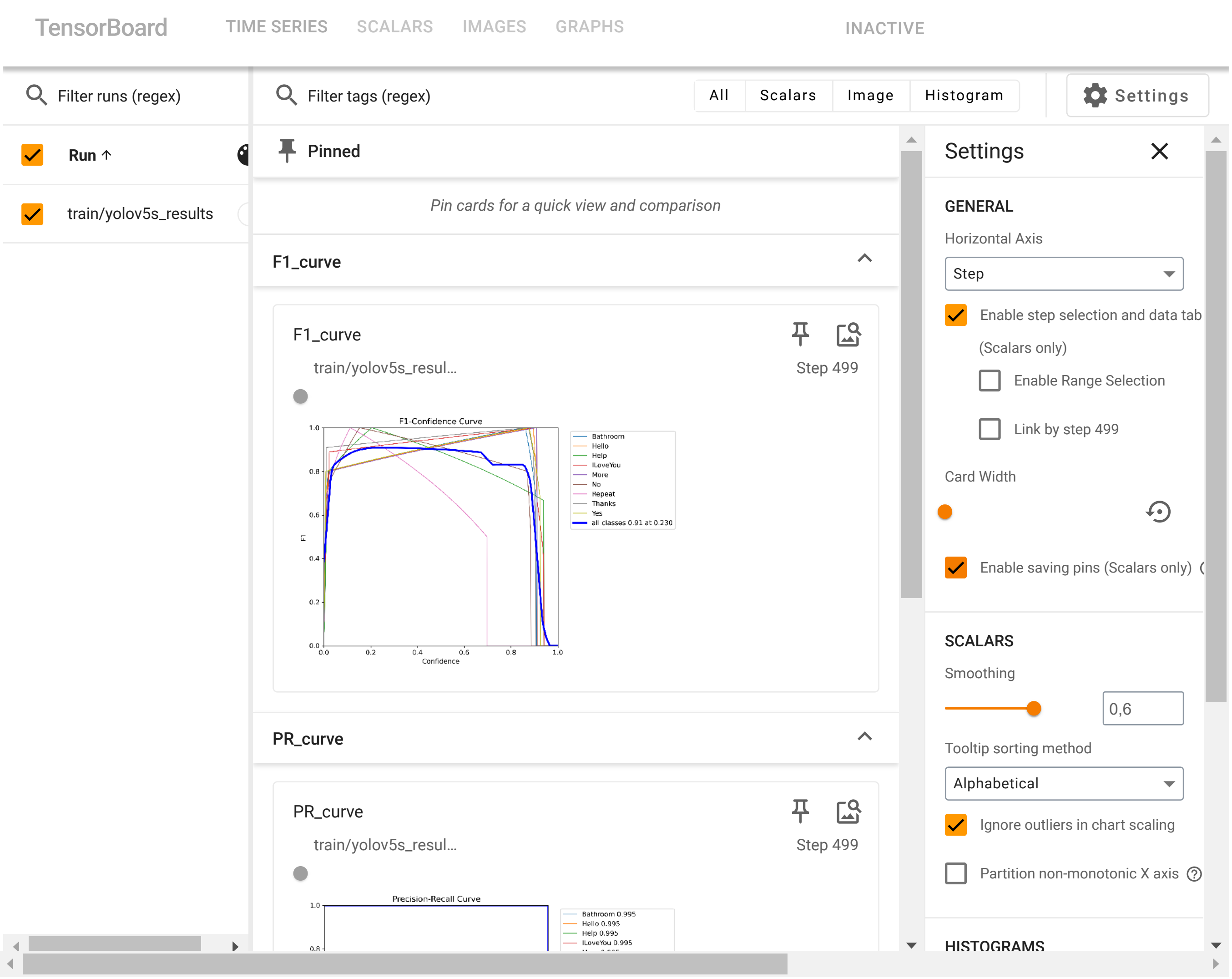
```
                   all         25         25      0.918      0.947      0.995      0.745

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Size
  0% 0/6 [00:00<?, ?it/s]/content/yolov5/train.py:412: FutureWarning: `torch.cuda.amp.autocast(args...)` is deprecated. Please us
  with torch.cuda.amp.autocast(amp):
    498/499      4.33G    0.02746    0.01062      0.022         29        640:  17% 1/6 [00:00<00:01,  4.41it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    498/499      4.33G    0.02243    0.01068    0.01665         31        640:  33% 2/6 [00:00<00:00,  4.20it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    498/499      4.33G     0.0197    0.01044    0.01255         33        640:  50% 3/6 [00:00<00:00,  3.90it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    498/499      4.33G    0.02049    0.01039    0.01394         31        640:  67% 4/6 [00:01<00:00,  3.87it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    498/499      4.33G    0.02146    0.01076    0.01665         34        640:  83% 5/6 [00:01<00:00,  3.83it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    498/499      4.33G    0.02143    0.01063    0.01871          6        640: 100% 6/6 [00:01<00:00,  4.27it/s]
                 Class     Images  Instances          P          R      mAP50   mAP50-95: 100% 1/1 [00:00<00:00,  2.78it/s]
                   all         25         25      0.916      0.948      0.995      0.746

      Epoch    GPU_mem   box_loss   obj_loss   cls_loss  Instances       Size
  0% 0/6 [00:00<?, ?it/s]/content/yolov5/train.py:412: FutureWarning: `torch.cuda.amp.autocast(args...)` is deprecated. Please us
  with torch.cuda.amp.autocast(amp):
    499/499      4.33G    0.02974    0.01512      0.024         41        640:  17% 1/6 [00:00<00:01,  4.41it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    499/499      4.33G    0.02829     0.0132    0.02236         31        640:  33% 2/6 [00:00<00:00,  4.15it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    499/499      4.33G    0.02873    0.01232    0.01842         27        640:  50% 3/6 [00:00<00:00,  4.20it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    499/499      4.33G    0.02538    0.01189    0.01548         29        640:  67% 4/6 [00:00<00:00,  4.26it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    499/499      4.33G    0.02453    0.01172    0.01615         32        640:  83% 5/6 [00:01<00:00,  4.04it/s]/content/yolov5/t
  with torch.cuda.amp.autocast(amp):
    499/499      4.33G    0.02377    0.01116    0.01402          5        640: 100% 6/6 [00:01<00:00,  4.45it/s]
                 Class     Images  Instances          P          R      mAP50   mAP50-95: 100% 1/1 [00:00<00:00,  2.61it/s]
                   all         25         25      0.913       0.95      0.995      0.743

500 epochs completed in 0.315 hours.
Optimizer stripped from runs/train/yolov5s_results/weights/last.pt, 15.0MB
Optimizer stripped from runs/train/yolov5s_results/weights/best.pt, 15.0MB

Validating runs/train/yolov5s_results/weights/best.pt...
Fusing layers...
custom_YOLOv5s summary: 182 layers, 7268094 parameters, 0 gradients
                 Class     Images  Instances          P          R      mAP50   mAP50-95: 100% 1/1 [00:00<00:00,  2.27it/s]
                   all         25         25      0.862      0.974      0.995      0.785
              Bathroom         25          2      0.759          1      0.995      0.796
                 Hello         25          2      0.755          1      0.995      0.895
                  Help         25          2          1      0.968      0.995      0.895
              ILoveYou         25          4      0.852          1      0.995      0.774
                  More         25          2      0.752          1      0.995      0.796
                    No         25          3          1      0.954      0.995      0.672
                Repeat         25          3          1      0.839      0.995      0.764
                Thanks         25          5       0.88          1      0.995      0.775
                   Yes         25          2       0.76          1      0.995      0.698
Results saved to runs/train/yolov5s_results
CPU times: user 11.1 s, sys: 1.33 s, total: 12.4 s
Wall time: 20min 2s
```

Evaluate Custom YOLOv5 Detector Performance

Training losses and performance metrics are saved to Tensorboard and also to a logfile defined above with the **--name** flag when we train. In our case, we named this `yolov5s_results`. (If given no name, it defaults to `results.txt`.) The results file is plotted as a png after training completes.

Note from Glenn: Partially completed `results.txt` files can be plotted with `from utils.utils import plot_results; plot_results()`.

```
%load_ext tensorboard
%tensorboard --logdir runs
```



☑ Run ↑

☑ train/yolov5s_results

F1_curve

F1_curve train/yolov5s_resul... Step 499

PR_curve

PR_curve train/yolov5s_resul... Step 499

Settings

GENERAL

Horizontal Axis: Step

☑ Enable step selection and data tab (Scalars only)

□ Enable Range Selection

□ Link by step 499

Card Width

☑ Enable saving pins (Scalars only)

SCALARS

Smoothing: 0,6

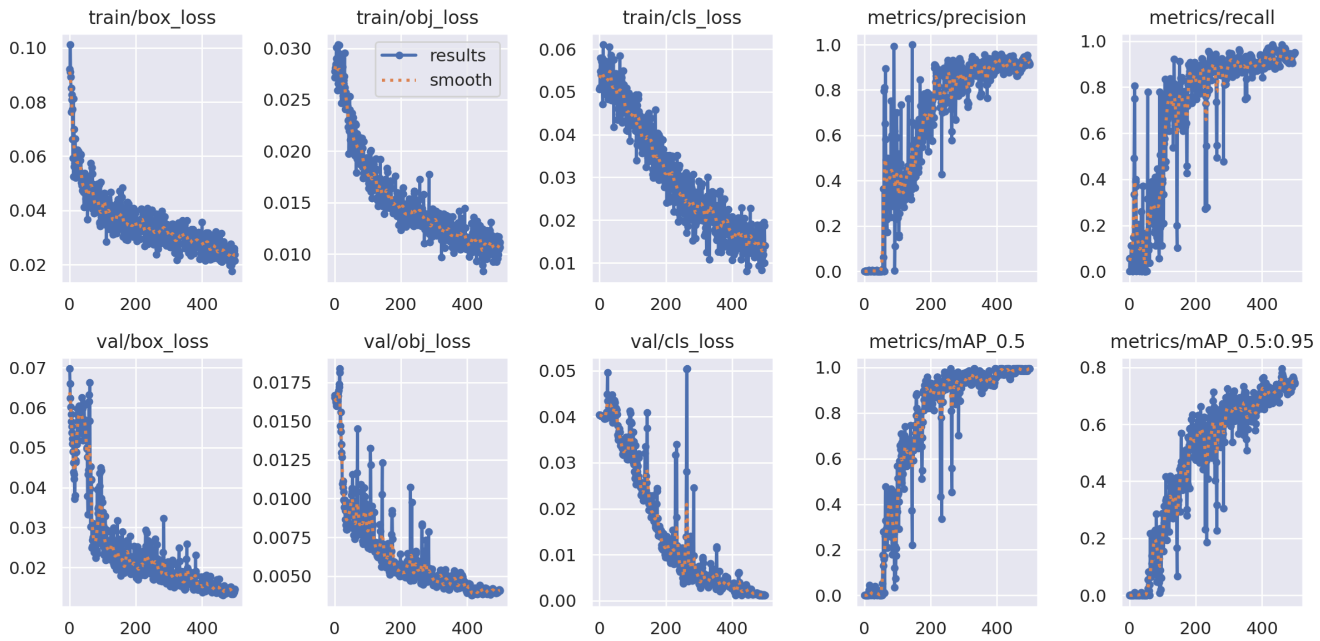
Tooltip sorting method: Alphabetical

☑ Ignore outliers in chart scaling

□ Partition non-monotonic X axis

HISTOGRAMS

```
# we can also output some older school graphs if the tensor board isn't working for whatever reason...
from utils.plots import plot_results  # plot results.txt as results.png
Image(filename='/content/yolov5/runs/train/yolov5s_results/results.png', width=1000)  # view results.png
```



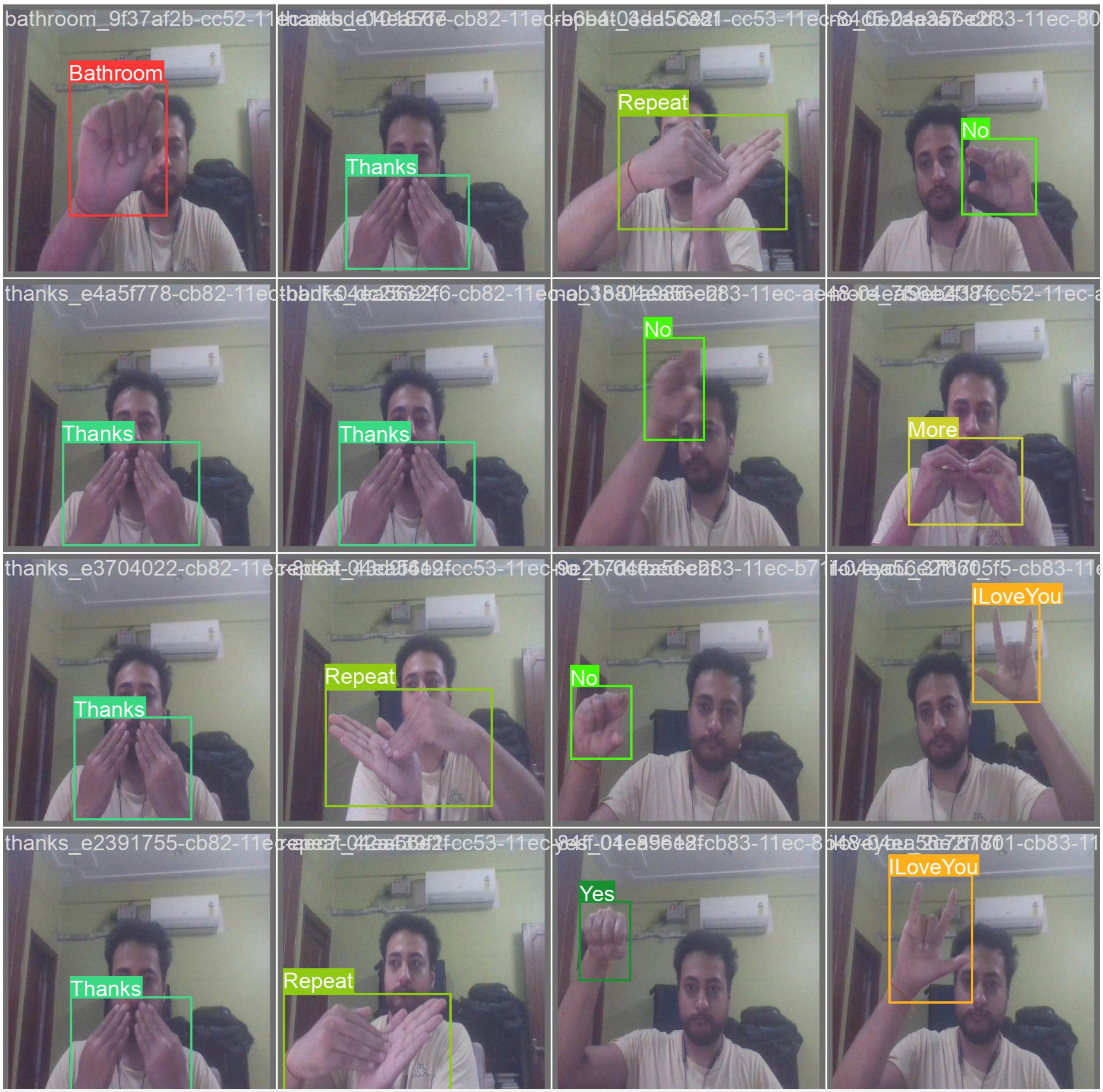
Curious? Visualize Our Training Data with Labels

After training starts, view `train*.jpg` images to see training images, labels and augmentation effects.

Note a mosaic dataloader is used for training (shown below), a new dataloading concept developed by Glenn Jocher and first featured in YOLOv4.

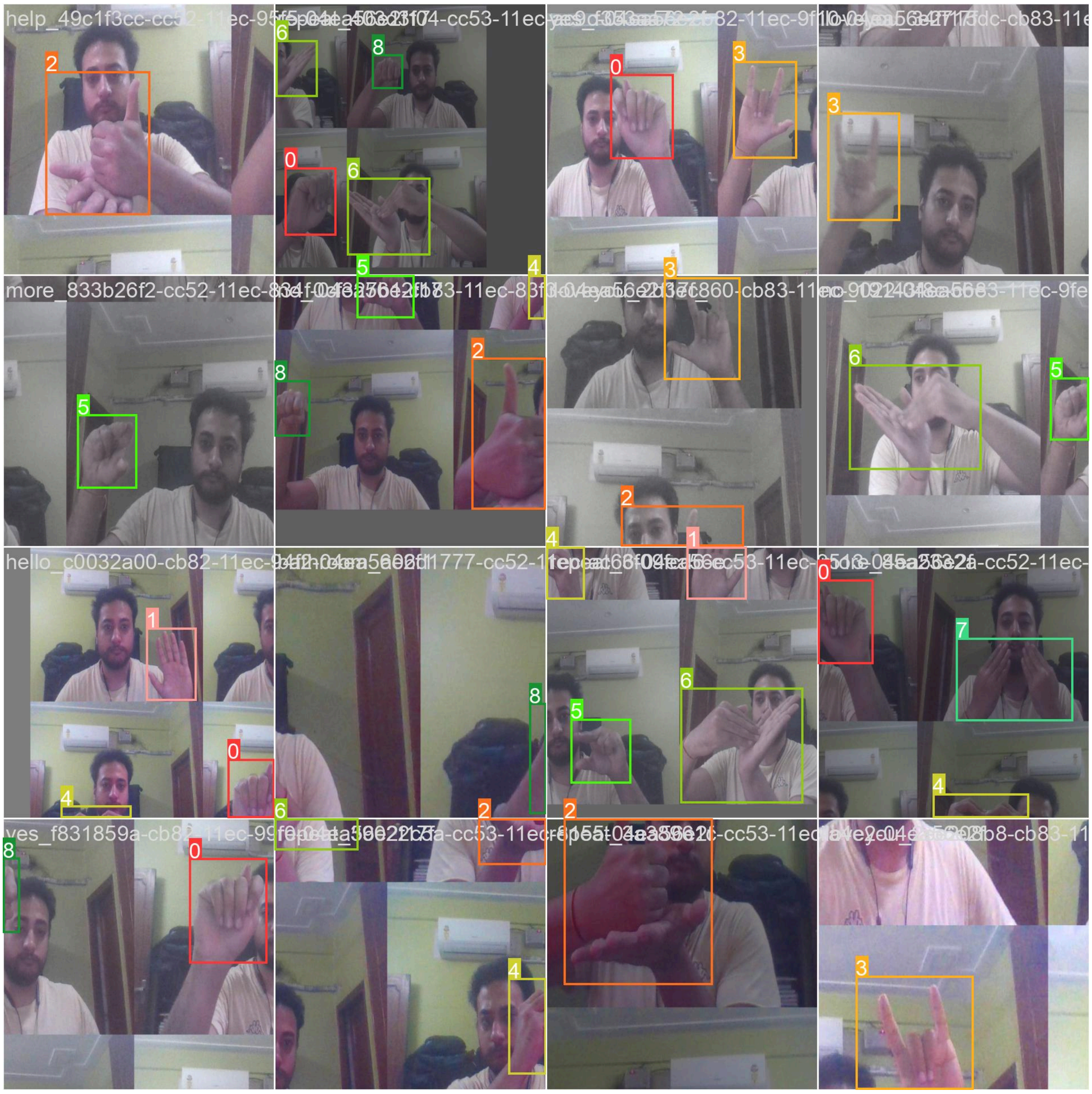
```
# first, display our ground truth data
print("GROUND TRUTH TRAINING DATA:")
Image(filename='/content/yolov5/runs/train/yolov5s_results/val_batch0_labels.jpg', width=900)
```

```
GROUND TRUTH TRAINING DATA:
```



```
# print out an augmented training example
print("GROUND TRUTH AUGMENTED TRAINING DATA:")
Image(filename='/content/yolov5/runs/train/yolov5s_results/train_batch0.jpg', width=900)
```

```
GROUND TRUTH AUGMENTED TRAINING DATA:
```



Run Inference With Trained Weights

Run inference with a pretrained checkpoint on contents of `test/images` folder downloaded from Roboflow.

```
# trained weights are saved by default in our weights folder
%ls runs/train/yolov5s_results/weights
```

```
best.pt  last.pt
```

```
# when we ran this, we saw .007 second inference time. That is 140 FPS on a TESLA P100!
# use the best weights!
%cd /content/yolov5/
!python detect.py --weights runs/train/yolov5s_results/weights/best.pt --img 640 --conf 0.5 --source ../test/images
```

```
/content/yolov5
detect: weights=['runs/train/yolov5s_results/weights/best.pt'], source=../test/images, data=data/coco128.yaml, imgsz=[640, 640], cor
YOLOv5 🚀 v7.0-398-g5cdad892 Python-3.11.11 torch-2.5.1+cu124 CUDA:0 (Tesla T4, 15095MiB)

Fusing layers...
custom_YOLOv5s summary: 182 layers, 7268094 parameters, 0 gradients
image 1/12 /content/test/images/bathroom_9a6808d4-cc52-11ec-8504-04ea56e2f17f_jpg.rf.66e5ccc08d415317f1a64463ca348e50.jpg: 640x640 1
image 2/12 /content/test/images/bathroom_a1a284cb-cc52-11ec-ab19-04ea56e2f17f_jpg.rf.3a98189ff600869ba1c60d1ec311e788.jpg: 640x640 1
image 3/12 /content/test/images/iloveyou_32888c06-cb83-11ec-a923-04ea56e2f17f_jpg.rf.e384beede0f61d268cb2a978b08641d4.jpg: 640x640 1
image 4/12 /content/test/images/iloveyou_33c01ce1-cb83-11ec-b1fc-04ea56e2f17f_jpg.rf.5bbc71b4c64350f50e03a1585d502e98.jpg: 640x640 1
image 5/12 /content/test/images/more_86d49c68-cc52-11ec-bc89-04ea56e2f17f_jpg.rf.5c2de6a5aeb7dfd0944e1ad1d6d96a4b.jpg: 640x640 1 Mor
image 6/12 /content/test/images/more_8807da17-cc52-11ec-b8ea-04ea56e2f17f_jpg.rf.77114157bab908ae2947bd182c219397.jpg: 640x640 1 Mor
image 7/12 /content/test/images/no_10975513-cb83-11ec-9171-04ea56e2f17f_jpg.rf.83139828f3e25a76fe899cfecd8340d1.jpg: 640x640 1 No, 1
image 8/12 /content/test/images/repeat_37cf0a3e-cc53-11ec-b6e0-04ea56e2f17f_jpg.rf.7e715b07af9629708abd5027ea3a6765.jpg: 640x640 1 R
image 9/12 /content/test/images/thanks_d60c2990-cb82-11ec-a41d-04ea56e2f17f_jpg.rf.3fb478d96f05265e4797e8e1e6aa8999.jpg: 640x640 1 T
image 10/12 /content/test/images/thanks_dd5af902-cb82-11ec-a8f0-04ea56e2f17f_jpg.rf.5f1e8eb1107ac10f677847ef718602cb.jpg: 640x640 1
image 11/12 /content/test/images/thanks_e5dd6aee-cb82-11ec-9abe-04ea56e2f17f_jpg.rf.7f5460f87972b99adc3dc5b17126b841.jpg: 640x640 1
```