```
!pip install ultralytics roboflow
```

```
Requirement already satisfied: six in /usr/local/lib/python3.12/dist-packages (from roboflow) (1.17.0)
Requirement already satisfied: urllib3>=1.26.6 in /usr/local/lib/python3.12/dist-packages (from roboflow) (2.5.0)
Requirement already satisfied: tqdm>=4.41.0 in /usr/local/lib/python3.12/dist-packages (from roboflow) (4.67.1)
Requirement already satisfied: requests-toolbelt in /usr/local/lib/python3.12/dist-packages (from roboflow) (1.0.0)
Collecting filetype (from roboflow)
  Downloading filetype-1.2.0-py2.py3-none-any.whl.metadata (6.5 kB)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (1.3.3)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (4.60.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (25.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (3.2.4)
Requirement already satisfied: charset_normalizer<4,>=2 in /usr/local/lib/python3.12/dist-packages (from requests>=2.23.0->ultralytics) (3.4.3)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.19.1)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (4.15.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (75.2.0)
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (1.13.3)
Requirement already satisfied: networkx in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.5)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.1.6)
Requirement already satisfied: fsspec in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (2025.3.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.77)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.77)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.80)
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (9.10.2.21)
Requirement already satisfied: nvidia-cublas-cu12==12.6.4.1 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.4.1)
Requirement already satisfied: nvidia-cufft-cu12==11.3.0.4 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (11.3.0.4)
Requirement already satisfied: nvidia-curand-cu12==10.3.7.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (10.3.7.77)
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (11.7.1.2)
Requirement already satisfied: nvidia-cusparse-cu12==12.5.4.2 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.5.4.2)
Requirement already satisfied: nvidia-cusparselt-cu12==0.7.1 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (0.7.1)
Requirement already satisfied: nvidia-nccl-cu12==2.27.3 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (2.27.3)
Requirement already satisfied: nvidia-nvtx-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.77)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.6.85 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.85)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (1.11.1.6)
Requirement already satisfied: triton==3.4.0 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.4.0)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/dist-packages (from sympy>=1.13.3->torch>=1.8.0->ultralytics) (1.3.0)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from jinja2->torch>=1.8.0->ultralytics) (3.0.2)
Downloading ultralytics-8.3.203-py3-none-any.whl (1.1 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.1/1.1 MB 37.2 MB/s eta 0:00:00
Downloading roboflow-1.2.9-py3-none-any.whl (88 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 88.7/88.7 kB 9.0 MB/s eta 0:00:00
Downloading idna-3.7-py3-none-any.whl (66 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 66.8/66.8 kB 5.0 MB/s eta 0:00:00
Downloading opencv_python_headless-4.10.0.84-cp37-abi3-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (49.9 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 49.9/49.9 MB 18.6 MB/s eta 0:00:00
Downloading pi_heif-1.1.0-cp312-cp312-manylinux_2_27_x86_64.manylinux_2_28_x86_64.whl (1.4 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.4/1.4 MB 82.6 MB/s eta 0:00:00
Downloading pillow_avif_plugin-1.5.2-cp312-cp312-manylinux_2_28_x86_64.whl (4.2 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.2/4.2 MB 117.0 MB/s eta 0:00:00
Downloading ultralytics_thop-2.0.17-py3-none-any.whl (28 kB)
Downloading filetype-1.2.0-py2.py3-none-any.whl (19 kB)
Installing collected packages: pillow-avif-plugin, filetype, pi-heif, opencv-python-headless, idna, ultralytics-thop, roboflow, ultralytics
  Attempting uninstall: opencv-python-headless
    Found existing installation: opencv-python-headless 4.12.0.88
    Uninstalling opencv-python-headless-4.12.0.88:
      Successfully uninstalled opencv-python-headless-4.12.0.88
  Attempting uninstall: idna
    Found existing installation: idna 3.10
    Uninstalling idna-3.10:
```

```
      Successfully uninstalled idna-3.10
Successfully installed filetype-1.2.0 idna-3.7 opencv-python-headless-4.10.0.84 pi-heif-1.1.0 pillow-avif-plugin-1.5.2 roboflow-1.2.9 ultralytics-8.3.203 ultralytics-thop-2.0.17
```

```
1 !pip install ultralytics kaggle
```

```
Requirement already satisfied: ultralytics in /usr/local/lib/python3.12/dist-packages (8.3.203)
Requirement already satisfied: kaggle in /usr/local/lib/python3.12/dist-packages (1.7.4.5)
Requirement already satisfied: numpy>=1.23.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (2.0.2)
Requirement already satisfied: matplotlib>=3.3.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (3.10.0)
Requirement already satisfied: opencv-python>=4.6.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (4.12.0.88)
Requirement already satisfied: pillow>=7.1.2 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (11.3.0)
Requirement already satisfied: pyyaml>=5.3.1 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (6.0.2)
Requirement already satisfied: requests>=2.23.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (2.32.4)
Requirement already satisfied: scipy>=1.4.1 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (1.16.2)
Requirement already satisfied: torch>=1.8.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (2.8.0+cu126)
Requirement already satisfied: torchvision>=0.9.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (0.23.0+cu126)
Requirement already satisfied: psutil in /usr/local/lib/python3.12/dist-packages (from ultralytics) (5.9.5)
Requirement already satisfied: polars in /usr/local/lib/python3.12/dist-packages (from ultralytics) (1.25.2)
Requirement already satisfied: ultralytics-thop>=2.0.0 in /usr/local/lib/python3.12/dist-packages (from ultralytics) (2.0.17)
Requirement already satisfied: bleach in /usr/local/lib/python3.12/dist-packages (from kaggle) (6.2.0)
Requirement already satisfied: certifi>=14.05.14 in /usr/local/lib/python3.12/dist-packages (from kaggle) (2025.8.3)
Requirement already satisfied: charset-normalizer in /usr/local/lib/python3.12/dist-packages (from kaggle) (3.4.3)
Requirement already satisfied: idna in /usr/local/lib/python3.12/dist-packages (from kaggle) (3.7)
Requirement already satisfied: protobuf in /usr/local/lib/python3.12/dist-packages (from kaggle) (5.29.5)
Requirement already satisfied: python-dateutil>=2.5.3 in /usr/local/lib/python3.12/dist-packages (from kaggle) (2.9.0.post0)
Requirement already satisfied: python-slugify in /usr/local/lib/python3.12/dist-packages (from kaggle) (8.0.4)
Requirement already satisfied: setuptools>=21.0.0 in /usr/local/lib/python3.12/dist-packages (from kaggle) (75.2.0)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.12/dist-packages (from kaggle) (1.17.0)
Requirement already satisfied: text-unidecode in /usr/local/lib/python3.12/dist-packages (from kaggle) (1.3)
Requirement already satisfied: tqdm in /usr/local/lib/python3.12/dist-packages (from kaggle) (4.67.1)
Requirement already satisfied: urllib3>=1.15.1 in /usr/local/lib/python3.12/dist-packages (from kaggle) (2.5.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.12/dist-packages (from kaggle) (0.5.1)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (1.3.3)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (4.60.0)
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (1.4.9)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (25.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib>=3.3.0->ultralytics) (3.2.4)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.19.1)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (4.15.0)
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (1.13.3)
Requirement already satisfied: networkx in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.5)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.1.6)
Requirement already satisfied: fsspec in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (2025.3.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.77)
Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.77)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.80)
Requirement already satisfied: nvidia-cudnn-cu12==9.10.2.21 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (9.10.2.21)
Requirement already satisfied: nvidia-cublas-cu12==12.6.4.1 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.4.1)
Requirement already satisfied: nvidia-cufft-cu12==11.3.0.4 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (11.3.0.4)
Requirement already satisfied: nvidia-curand-cu12==10.3.7.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (10.3.7.77)
Requirement already satisfied: nvidia-cusolver-cu12==11.7.1.2 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (11.7.1.2)
Requirement already satisfied: nvidia-cusparse-cu12==12.5.4.2 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.5.4.2)
Requirement already satisfied: nvidia-cusparselt-cu12==0.7.1 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (0.7.1)
Requirement already satisfied: nvidia-nccl-cu12==2.27.3 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (2.27.3)
Requirement already satisfied: nvidia-nvtx-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.77)
Requirement already satisfied: nvidia-nvjitlink-cu12==12.6.85 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (12.6.85)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (1.11.1.6)
Requirement already satisfied: triton==3.4.0 in /usr/local/lib/python3.12/dist-packages (from torch>=1.8.0->ultralytics) (3.4.0)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/dist-packages (from sympy>=1.13.3->torch>=1.8.0->ultralytics) (1.3.0)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from jinja2->torch>=1.8.0->ultralytics) (3.0.2)
```

```
from google.colab import files
files.upload()
!mkdir -p ~/.kaggle
!cp kaggle.json ~/.kaggle/
!chmod 600 ~/.kaggle/kaggle.json
```

Choose Files kaggle.json

kaggle.json(application/json) - 65 bytes, last modified: n/a - 100% done

```
Saving kaggle.json to kaggle.json
```

```
!kaggle datasets download -d andrewmvd/pothole-detection

!unzip pothole-detection.zip -d pothole-detection
```

```
inflating: pothole-detection/images/potholes641.png
inflating: pothole-detection/images/potholes642.png
inflating: pothole-detection/images/potholes643.png
inflating: pothole-detection/images/potholes644.png
inflating: pothole-detection/images/potholes645.png
inflating: pothole-detection/images/potholes646.png
inflating: pothole-detection/images/potholes647.png
inflating: pothole-detection/images/potholes648.png
inflating: pothole-detection/images/potholes649.png
inflating: pothole-detection/images/potholes65.png
inflating: pothole-detection/images/potholes650.png
inflating: pothole-detection/images/potholes651.png
inflating: pothole-detection/images/potholes652.png
inflating: pothole-detection/images/potholes653.png
inflating: pothole-detection/images/potholes654.png
inflating: pothole-detection/images/potholes655.png
inflating: pothole-detection/images/potholes656.png
inflating: pothole-detection/images/potholes657.png
inflating: pothole-detection/images/potholes658.png
inflating: pothole-detection/images/potholes659.png
inflating: pothole-detection/images/potholes66.png
inflating: pothole-detection/images/potholes660.png
inflating: pothole-detection/images/potholes661.png
inflating: pothole-detection/images/potholes662.png
inflating: pothole-detection/images/potholes663.png
inflating: pothole-detection/images/potholes664.png
inflating: pothole-detection/images/potholes67.png
inflating: pothole-detection/images/potholes68.png
inflating: pothole-detection/images/potholes69.png
inflating: pothole-detection/images/potholes7.png
inflating: pothole-detection/images/potholes70.png
inflating: pothole-detection/images/potholes71.png
inflating: pothole-detection/images/potholes72.png
inflating: pothole-detection/images/potholes73.png
inflating: pothole-detection/images/potholes74.png
inflating: pothole-detection/images/potholes75.png
inflating: pothole-detection/images/potholes76.png
inflating: pothole-detection/images/potholes77.png
inflating: pothole-detection/images/potholes78.png
inflating: pothole-detection/images/potholes79.png
inflating: pothole-detection/images/potholes8.png
inflating: pothole-detection/images/potholes80.png
inflating: pothole-detection/images/potholes81.png
inflating: pothole-detection/images/potholes82.png
```

```
  inflating: pothole-detection/images/potholes83.png
  inflating: pothole-detection/images/potholes84.png
  inflating: pothole-detection/images/potholes85.png
  inflating: pothole-detection/images/potholes86.png
  inflating: pothole-detection/images/potholes87.png
  inflating: pothole-detection/images/potholes88.png
  inflating: pothole-detection/images/potholes89.png
  inflating: pothole-detection/images/potholes9.png
  inflating: pothole-detection/images/potholes90.png
  inflating: pothole-detection/images/potholes91.png
  inflating: pothole-detection/images/potholes92.png
  inflating: pothole-detection/images/potholes93.png
  inflating: pothole-detection/images/potholes94.png
  inflating: pothole-detection/images/potholes95.png
  inflating: pothole-detection/images/potholes96.png
```

```
import os
import xml.etree.ElementTree as ET

images_path = "pothole-detection/images"
annotations_path = "pothole-detection/annotations"
yolo_labels_path = "pothole-detection/labels"

os.makedirs(yolo_labels_path, exist_ok=True)

def convert(size, box):
    dw = 1. / size[0]
    dh = 1. / size[1]
    x = (box[0] + box[1]) / 2.0 - 1
    y = (box[2] + box[3]) / 2.0 - 1
    w = box[1] - box[0]
    h = box[3] - box[2]
    x = x * dw
    w = w * dw
    y = y * dh
    h = h * dh
    return (x, y, w, h)

for xml_file in os.listdir(annotations_path):
    if not xml_file.endswith('.xml'):
        continue

    tree = ET.parse(os.path.join(annotations_path, xml_file))
    root = tree.getroot()

    img_file = root.find('filename').text
    size = root.find('size')
    w = int(size.find('width').text)
    h = int(size.find('height').text)

    yolo_file = os.path.join(yolo_labels_path, xml_file.replace('.xml', '.txt'))
    with open(yolo_file, 'w') as f:
        for obj in root.iter('object'):
            cls = 0
            xmlbox = obj.find('bndbox')
            b = (
                int(xmlbox.find('xmin').text),
                int(xmlbox.find('xmax').text),
                int(xmlbox.find('ymin').text),
                int(xmlbox.find('ymax').text)
            )
            bb = convert((w, h), b)
            f.write(f"{cls} {' '.join([str(a) for a in bb])}\n")
```

```
!ls pothole-detection/labels | head
```

```
potholes0.txt
potholes100.txt
potholes101.txt
potholes102.txt
potholes103.txt
potholes104.txt
potholes105.txt
potholes106.txt
potholes107.txt
potholes108.txt
```

```
import os
import shutil
import random

src_images = "/content/pothole-detection/images"
src_labels = "/content/pothole-detection/labels"
dest = "/content/pothole_yolo"
train_ratio = 0.8

for split in ["train", "val"]:
    os.makedirs(f"{dest}/images/{split}", exist_ok=True)
    os.makedirs(f"{dest}/labels/{split}", exist_ok=True)

images = [f for f in os.listdir(src_images) if f.endswith(".png")]
random.shuffle(images)
split_idx = int(len(images)*train_ratio)

train_imgs = images[:split_idx]
val_imgs = images[split_idx:]

for img_list, split in [(train_imgs, "train"), (val_imgs, "val")]:
    for img in img_list:
        shutil.copy(os.path.join(src_images, img), f"{dest}/images/{split}/")
        label_file = img.replace(".png", ".txt")
        shutil.copy(os.path.join(src_labels, label_file), f"{dest}/labels/{split}/")
```

```
%%writefile /content/pothole_yolo/pothole.yaml
train: /content/pothole_yolo/images/train
val: /content/pothole_yolo/images/val

nc: 1
names: ['pothole']
```

```
Writing /content/pothole_yolo/pothole.yaml
```

```
from google.colab import files
uploaded = files.upload()
```

```
Choose Files  yolo11n.pt
yolo11n.pt(n/a) - 5613764 bytes, last modified: n/a - 100% done
Saving yolo11n.pt to yolo11n.pt
```

```
!mv yolo11n.pt yolov11n.pt
```

```
!ls -lh yolov11n.pt
```

```
-rw-r--r-- 1 root root 5.4M Sep 25 14:46 yolov11n.pt
```

```
from ultralytics import YOLO

model = YOLO("yolov11n.pt")

model.train(
    data="/content/pothole_yolo/pothole.yaml",
    epochs=50,
    imgsz=640
)
```

```
                0.68817,     0.68817,     0.68817,     0.68817,     0.68817,     0.68817,     0.68742,     0.6865,     0.68559,     0.68428,     0.68288,     0.68237,     0.68191,
0.68145,     0.68099,     0.68053,     0.68011,     0.67994,     0.67836,     0.67724,     0.67678,     0.67632,     0.67586,
                0.6754,     0.67494,     0.67398,     0.6726,     0.67149,     0.67058,     0.66966,     0.66935,     0.66935,     0.66935,     0.66935,     0.66935,     0.66935,
0.66935,     0.66935,     0.66935,     0.66632,     0.66592,     0.66553,     0.66514,     0.66474,     0.66435,     0.6639,
                0.66252,     0.66099,     0.65842,     0.65704,     0.65591,     0.65582,     0.65536,     0.6549,     0.65444,     0.65398,     0.65352,     0.64785,     0.64785,
0.64516,     0.64516,     0.64516,     0.64516,     0.64516,     0.64516,     0.64516,     0.64516,     0.64516,     0.64516,
                0.64516,     0.64516,     0.64468,     0.64399,     0.6433,     0.64262,     0.64193,     0.64124,     0.64055,     0.63986,     0.63897,     0.63805,     0.63713,
0.63444,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,
                0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63441,
0.63441,     0.63441,     0.63441,     0.63441,     0.63441,     0.63379,     0.63287,     0.63195,     0.63104,     0.63012,
                0.6292,     0.62847,     0.62778,     0.62709,     0.6264,     0.62634,     0.62634,     0.62634,     0.62227,     0.62097,     0.62097,     0.62097,     0.62097,
0.62097,     0.62097,     0.62097,     0.62097,     0.62097,     0.62097,     0.61885,     0.61828,     0.61828,     0.61828,
                0.61828,     0.61828,     0.61702,     0.61564,     0.61511,     0.61461,     0.61411,     0.6136,     0.6131,     0.6129,     0.6129,     0.61201,     0.61063,
0.60829,     0.60734,     0.60708,     0.60681,     0.60655,     0.60629,     0.60603,     0.60576,     0.6055,     0.60524,
                0.60498,     0.60462,     0.60416,     0.6037,     0.60324,     0.60278,     0.60232,     0.60215,     0.60215,     0.60215,     0.60215,     0.6015,     0.59946,
0.5992,     0.59828,     0.59737,     0.59677,     0.59677,     0.59677,     0.59593,     0.59501,     0.59409,     0.5934,
                0.59271,     0.59203,     0.59136,     0.59094,     0.59051,     0.59009,     0.58966,     0.58924,     0.58882,     0.58768,     0.5863,     0.5858,     0.58553,
0.58525,     0.58498,     0.5847,     0.58442,     0.58415,     0.58387,     0.5836,     0.58053,     0.57789,     0.57678,
                0.57568,     0.57355,     0.57079,     0.56989,     0.56989,     0.56989,     0.56989,     0.56714,     0.56692,     0.5667,     0.56648,     0.56626,     0.56604,
0.56582,     0.5656,     0.56538,     0.56516,     0.56494,     0.56472,     0.56427,     0.56167,     0.56029,     0.55645,
                0.55645,     0.55645,     0.55512,     0.55305,     0.55076,     0.54966,     0.54856,     0.54722,     0.54584,     0.5457,     0.5457,     0.5457,     0.5457,
0.5457,     0.5457,     0.54558,     0.54374,     0.54301,     0.54301,     0.54301,     0.54301,     0.54301,     0.54301,
                0.54301,     0.54301,     0.54301,     0.54301,     0.54301,     0.54231,     0.54047,     0.53779,     0.53711,     0.53656,     0.53601,     0.53546,     0.53189,
0.52798,     0.52353,     0.52243,     0.52133,     0.52022,     0.51912,     0.51749,     0.51599,     0.51543,     0.51488,
                0.51433,     0.51378,     0.51344,     0.51344,     0.51344,     0.51344,     0.51237,     0.51127,     0.50806,     0.50806,     0.50806,     0.50806,     0.50806,
0.50806,     0.50806,     0.50806,     0.50806,     0.50806,     0.50664,     0.50247,     0.50179,     0.5011,     0.50041,
                0.49686,     0.49576,     0.49466,     0.49061,     0.48878,     0.48786,     0.48695,     0.48496,     0.48276,     0.48118,     0.4779,     0.47698,     0.47606,
0.47514,     0.47422,     0.4733,     0.47224,     0.47114,     0.46845,     0.46774,     0.46774,     0.46774,     0.46379,
                0.46237,     0.46237,     0.46237,     0.46135,     0.45648,     0.4514,     0.44956,     0.44773,     0.44571,     0.44237,     0.43953,     0.43672,     0.43548,
0.43402,     0.43094,     0.42894,     0.42756,     0.42403,     0.42324,     0.42245,     0.42204,     0.42022,     0.41935,
                0.41935,     0.41776,     0.415,     0.40956,     0.4077,     0.40632,     0.40306,     0.40227,     0.40148,     0.4007,     0.39833,     0.39634,     0.39317,
0.39127,     0.38989,     0.3895,     0.3892,     0.38889,     0.38858,     0.38828,     0.38797,     0.38767,     0.38736,
                0.38697,     0.38605,     0.38513,     0.38401,     0.38218,     0.37903,     0.37903,     0.37903,     0.37597,     0.37487,     0.37377,     0.37118,     0.3697,
```

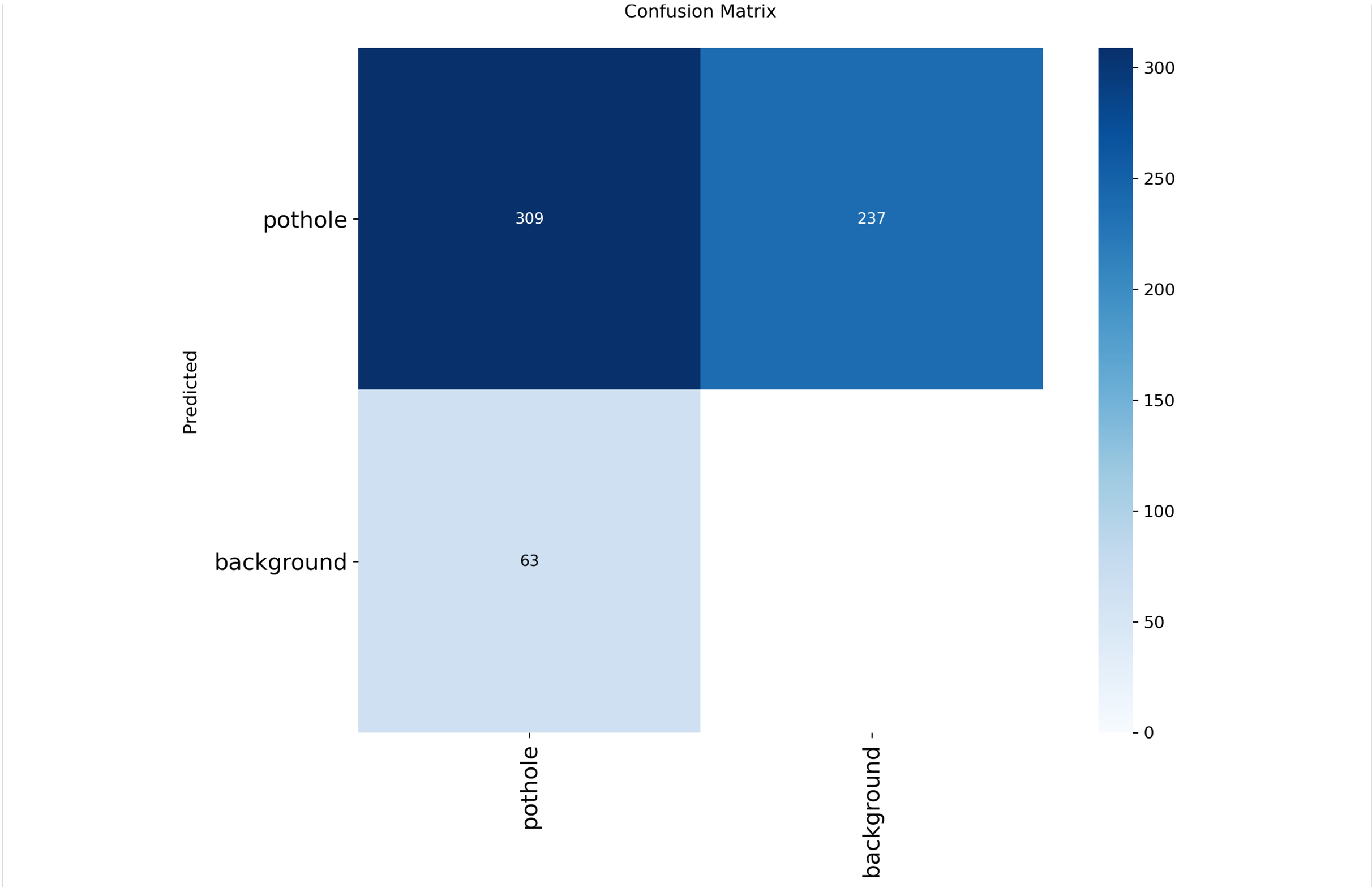
```
0.36832,     0.36292,     0.36153,     0.35997,     0.35599,     0.35164,     0.34779,     0.34369,     0.34094,     0.33836,
          0.33652,     0.33469,     0.33261,     0.32905,     0.32649,     0.3248,     0.32343,     0.31883,     0.31138,     0.31027,     0.30917,     0.30646,     0.30535,
0.30425,     0.30069,     0.29557,     0.29419,     0.29262,      0.2894,     0.28717,     0.28648,     0.28579,      0.2851,
          0.28067,     0.27515,     0.27192,     0.26682,     0.26372,     0.26096,     0.25566,     0.25364,      0.2518,     0.24988,     0.24584,     0.24184,     0.24046,
0.23365,     0.23182,     0.22757,     0.21668,      0.2058,      0.1976,     0.19306,     0.19122,     0.17707,     0.17597,
          0.17487,     0.17098,     0.16709,     0.16412,     0.16311,     0.16219,     0.15848,     0.15297,     0.14772,     0.14588,      0.1408,      0.1367,     0.12857,
0.12608,      0.1247,     0.12233,     0.10948,      0.1073,     0.10651,     0.10572,     0.10494,     0.10243,     0.09295,
         0.086304,    0.083407,    0.080652,    0.077836,    0.071109,    0.068866,    0.061723,    0.060621,    0.059519,    0.057332,    0.050138,     0.04876,    0.044359,
0.042644,    0.041266,    0.039889,    0.038511,     0.03563,    0.032533,    0.031431,    0.030513,    0.029594,    0.025093,
         0.021443,    0.018797,    0.018373,     0.01795,    0.017526,    0.017102,    0.016678,    0.016254,    0.012241,   0.0079943,   0.0077042,   0.0074142,   0.0071241,
0.0068341,    0.006544,    0.006254,   0.0059639,   0.0056739,   0.0053839,   0.0047053,   0.0040164,   0.0033276,           0,
               0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
               0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
               0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,          0]]), 'Confidence', 'Recall']]
fitness: np.float64(0.5207394435845443)
keys: ['metrics/precision(B)', 'metrics/recall(B)', 'metrics/mAP50(B)', 'metrics/mAP50-95(B)']
maps: array([    0.52074])
names: {0: 'pothole'}
nt_per_class: array([372])
nt_per_image: array([133])
results_dict: {'metrics/precision(B)': 0.811987240839706, 'metrics/recall(B)': 0.7150537634408602, 'metrics/mAP50(B)': 0.8021540086501076, 'metrics/mAP50-95(B)': 0.5207394435845443,
'fitness': 0.5207394435845443}
save_dir: PosixPath('/content/runs/detect/train')
speed: {'preprocess': 0.3198847744381356, 'inference': 4.521828210528797, 'loss': 0.0003998345875474922, 'postprocess': 6.12033751879341}
```

```
1 !pip install albumentations --quiet
2
3 from ultralytics import YOLO
4
5 model = YOLO("yolov11n.pt")
6
7 model.train(
8     data="/content/pothole_yolo/pothole.yaml",
9     epochs=70,
10     imgsz=640,
11     batch=16,
12     augment=True,
13     lr0=0.001,
14     patience=10,
15 )
```

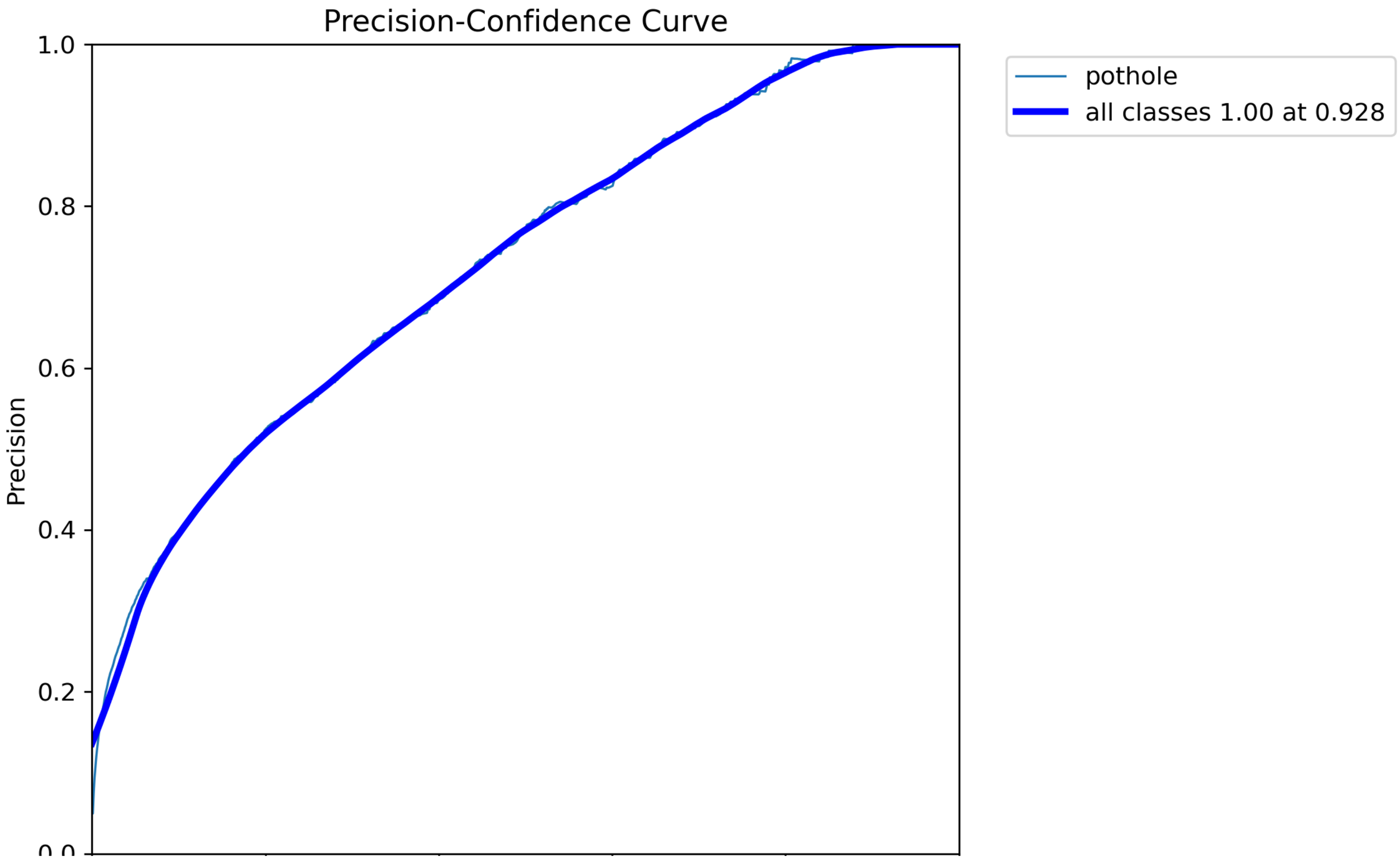
```
          0.73145,     0.73118,     0.73118,     0.72771,     0.72633,     0.72581,     0.72581,     0.72544,     0.72489,     0.72434,     0.72378,     0.72323,     0.72312,
0.72312,     0.72312,     0.72312,     0.72189,     0.72051,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,
          0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,
0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,     0.72043,
          0.72043,     0.72043,     0.72043,     0.71944,     0.71806,     0.71668,     0.71531,     0.71393,     0.71255,     0.70998,     0.70968,     0.70968,     0.70968,
0.70968,     0.70968,     0.70968,     0.70951,     0.70699,     0.70669,      0.7043,     0.70419,      0.7035,     0.70281,
          0.70212,     0.70161,     0.70161,     0.70161,     0.70161,     0.70161,     0.70161,     0.70161,     0.70161,     0.70161,     0.70161,     0.70092,     0.69954,
0.69842,      0.6975,     0.69658,     0.69599,      0.6956,      0.6952,     0.69481,     0.69442,     0.69402,     0.69363,
          0.69311,     0.69256,     0.69201,     0.69146,     0.69091,     0.68985,     0.68875,     0.68817,     0.68548,     0.68548,     0.68548,     0.68548,     0.68548,
0.68548,     0.68548,     0.68548,     0.68548,     0.68548,     0.68548,     0.68548,     0.68548,     0.68548,     0.68548,
          0.68548,     0.68548,     0.68422,     0.68284,     0.68147,     0.68009,     0.67899,     0.67789,     0.67473,     0.67418,     0.67326,     0.67234,     0.67143,
0.67051,     0.66959,      0.6673,     0.66561,     0.66423,     0.66398,     0.66282,     0.66144,     0.66129,     0.66129,
          0.66129,     0.66129,     0.66129,     0.66129,     0.66129,     0.66129,     0.66129,     0.66129,     0.66129,     0.66129,     0.66071,     0.65796,     0.65591,
0.65591,     0.65591,     0.65591,     0.65591,     0.65591,     0.65591,     0.65591,     0.65591,     0.65591,      0.655,
          0.65409,     0.65323,     0.65323,     0.65323,     0.65323,     0.65287,     0.65232,     0.65177,     0.65121,     0.65066,     0.64969,     0.64859,     0.64768,
```

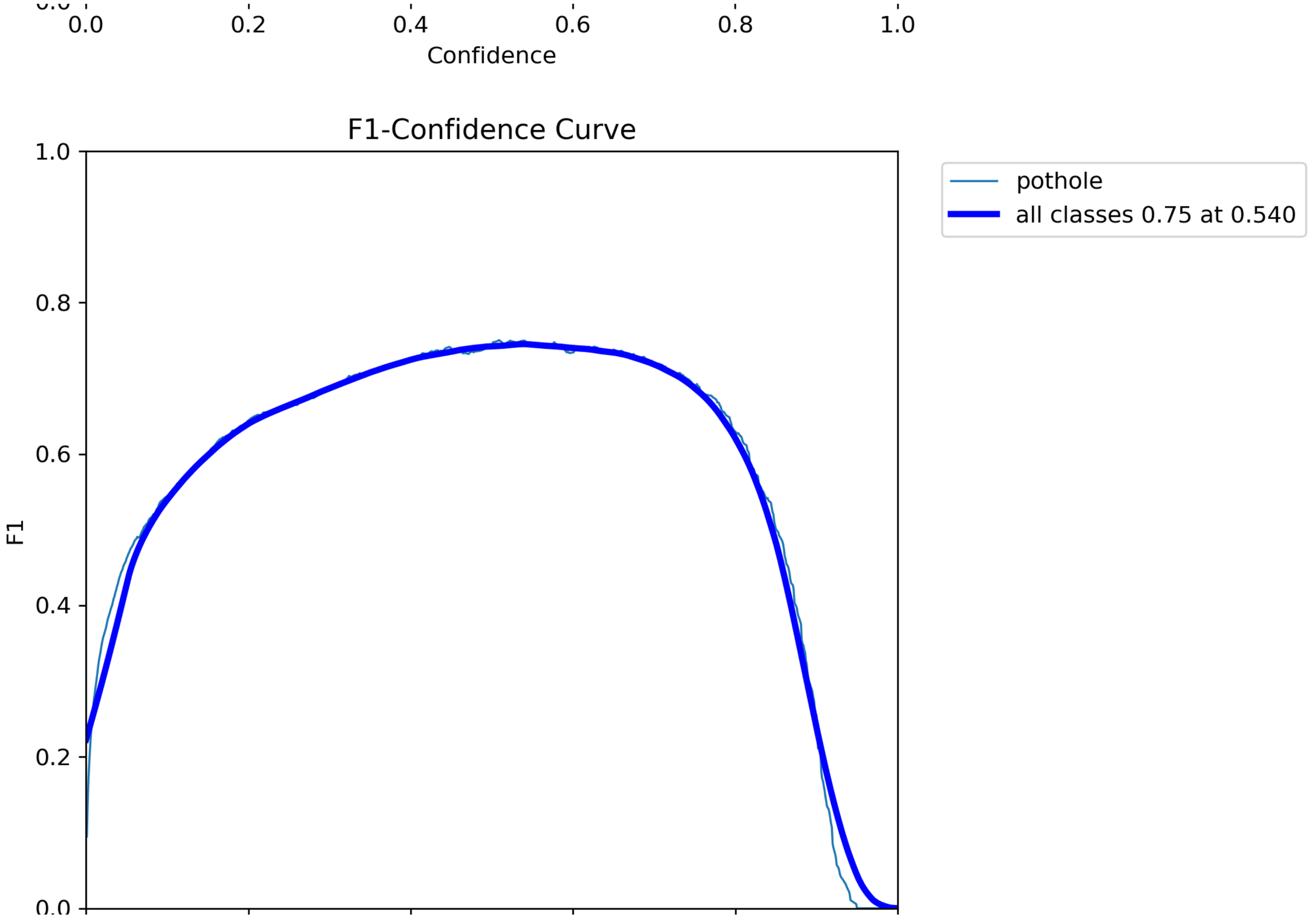
```
0.64718,     0.64668,     0.64618,     0.64568,     0.64518,     0.64463,     0.64408,     0.64353,     0.64298,     0.64247,
          0.64247,     0.64247,     0.63978,     0.63978,     0.63978,     0.63978,     0.63955,     0.63863,     0.63771,     0.63441,     0.63441,     0.63201,     0.63172,
0.63172,     0.63172,     0.63128,     0.63036,     0.62944,     0.62842,     0.62732,     0.62366,     0.62366,     0.62366,
          0.62366,     0.62366,     0.62366,     0.62097,     0.62097,     0.62097,     0.62097,     0.62097,     0.61857,     0.61489,      0.6141,     0.61331,      0.6129,
0.6129,      0.6129,      0.6129,      0.6129,      0.6129,      0.6129,      0.6129,      0.6129,      0.6101,     0.60955,
           0.609,     0.60845,     0.60789,     0.60716,     0.60606,     0.60495,     0.60484,     0.59962,     0.59842,     0.59732,     0.59677,     0.59677,     0.59677,
0.59677,     0.59677,     0.59639,     0.59409,     0.59396,     0.59327,     0.59258,     0.59189,     0.59061,     0.58871,
          0.58871,     0.58638,     0.58442,     0.58258,     0.58075,     0.57891,     0.57527,     0.57527,     0.57527,     0.57527,     0.57527,     0.57527,     0.57501,
0.57318,     0.57258,     0.57258,     0.57258,     0.57258,     0.57173,     0.57063,     0.56928,     0.56744,      0.5672,
          0.56423,     0.56355,     0.56286,     0.56217,     0.55914,     0.55909,     0.55799,     0.55689,     0.55562,     0.55424,     0.55197,     0.55066,     0.55005,
0.54944,     0.54882,     0.54839,     0.54839,     0.54533,     0.54423,     0.54312,     0.53807,     0.53594,     0.53444,
          0.53334,     0.53225,     0.53195,     0.53164,     0.53133,     0.53103,     0.53072,     0.53042,     0.53011,      0.5298,     0.52957,     0.52812,     0.52627,
0.52548,      0.5247,      0.5238,     0.52269,     0.52159,     0.51643,     0.51526,     0.51434,     0.51075,      0.5066,
          0.50231,     0.49893,     0.49731,     0.49731,     0.49551,     0.49338,     0.49177,     0.49098,     0.49019,      0.4894,     0.48753,     0.48236,     0.47919,
0.4734,      0.47147,     0.46963,      0.4678,     0.46596,     0.46449,     0.46339,     0.46237,      0.4622,     0.46036,
          0.45852,     0.45668,     0.45485,     0.45043,     0.44759,     0.44605,     0.44537,     0.44468,     0.44399,     0.43751,     0.43567,     0.43301,     0.42124,
0.41941,     0.41668,     0.41396,     0.41285,     0.41175,     0.40585,     0.40516,     0.40447,     0.40378,      0.4027,
          0.39218,      0.3908,      0.3893,     0.38746,     0.38489,     0.38327,     0.38189,     0.37931,     0.37656,     0.37507,     0.37369,     0.37366,     0.37028,
0.36959,      0.3689,     0.36776,     0.36225,     0.35637,     0.35392,     0.34572,     0.34021,     0.33558,     0.33374,
          0.33248,     0.33137,     0.32749,     0.32611,     0.32456,     0.32272,     0.32088,     0.31736,     0.31185,     0.30371,     0.30083,     0.29508,     0.29398,
0.29236,     0.28916,     0.28402,      0.2777,     0.27399,     0.27308,     0.27216,     0.26722,     0.25365,     0.25155,
          0.25017,     0.24759,     0.24215,     0.23845,     0.23661,     0.23388,     0.23106,      0.2148,      0.2116,     0.21022,     0.20587,     0.20351,     0.19577,
0.19249,     0.18429,     0.17709,     0.17571,     0.17393,     0.17147,     0.16963,     0.16701,     0.16237,     0.15902,
          0.15153,      0.148,     0.14606,     0.13698,     0.11824,     0.11746,     0.11667,     0.11588,     0.099065,    0.093777,    0.09194,     0.088111,    0.08469,
0.079912,    0.076356,    0.072234,    0.071131,    0.070029,    0.067479,    0.063379,     0.05942,    0.056524,    0.04436,
         0.041605,    0.03934,    0.037438,    0.034419,    0.02946,    0.028541,    0.027623,    0.025816,    0.022897,    0.021315,    0.020527,    0.01974,    0.018953,
0.018057,    0.017139,     0.01622,    0.014888,     0.01351,    0.012394,    0.011292,    0.0093454,   0.0053589,   0.0049916,
        0.0046242,   0.0042568,   0.0038894,   0.003522,   0.0031546,   0.0027872,           0,           0,           0,           0,           0,           0,           0,
0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
             0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
0,           0,           0,           0,           0,           0,           0,           0,           0,           0,
             0,           0,           0,           0,           0,           0,           0,           0,           0,           0]]), 'Confidence', 'Recall']]
fitness: np.float64(0.5205651752687769)
keys: ['metrics/precision(B)', 'metrics/recall(B)', 'metrics/mAP50(B)', 'metrics/mAP50-95(B)']
maps: array([    0.52057])
names: {0: 'pothole'}
nt_per_class: array([372])
nt_per_image: array([133])
results_dict: {'metrics/precision(B)': 0.8053019857464302, 'metrics/recall(B)': 0.7016129032258065, 'metrics/mAP50(B)': 0.8021314732629288, 'metrics/mAP50-95(B)': 0.5205651752687769,
'fitness': 0.5205651752687769}
save_dir: PosixPath('/content/runs/detect/train2')
speed: {'preprocess': 0.24776042105908605, 'inference': 192.18036465413653, 'loss': 0.0003055263158258688, 'postprocess': 1.5282293458623921}
stats: {'tp': [], 'conf': [], 'pred_cls': [], 'target_cls': [], 'target_img': []}
task: 'detect'
```

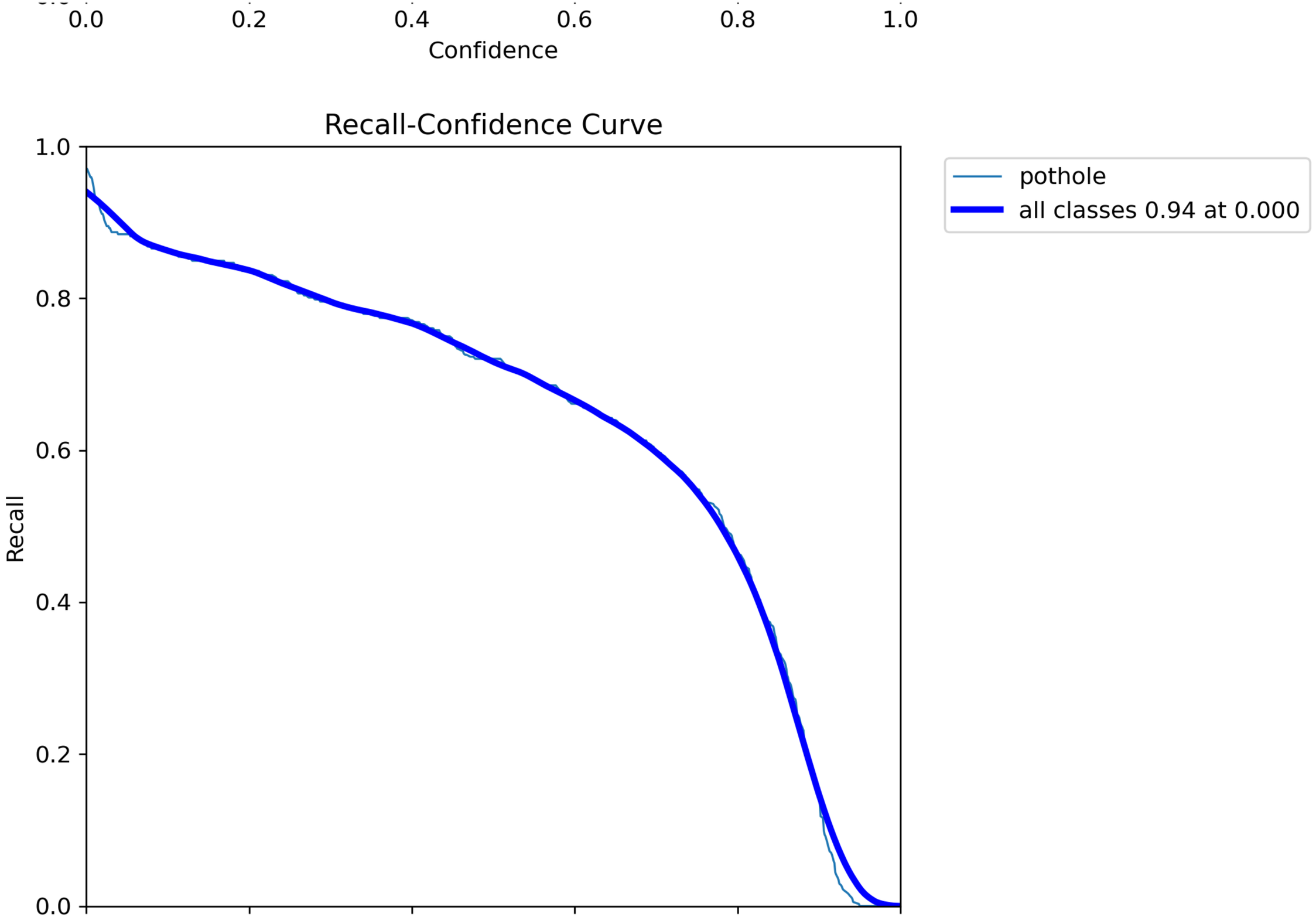
```
from IPython.display import Image, display
import glob

run_folder = "/content/runs/detect/train2/"

all_pngs = glob.glob(run_folder + "*.png")

if all_pngs:
    for img_file in all_pngs:
        display(Image(filename=img_file))
else:
    print("No plot images found in the folder. Only model weights may be saved.")
```

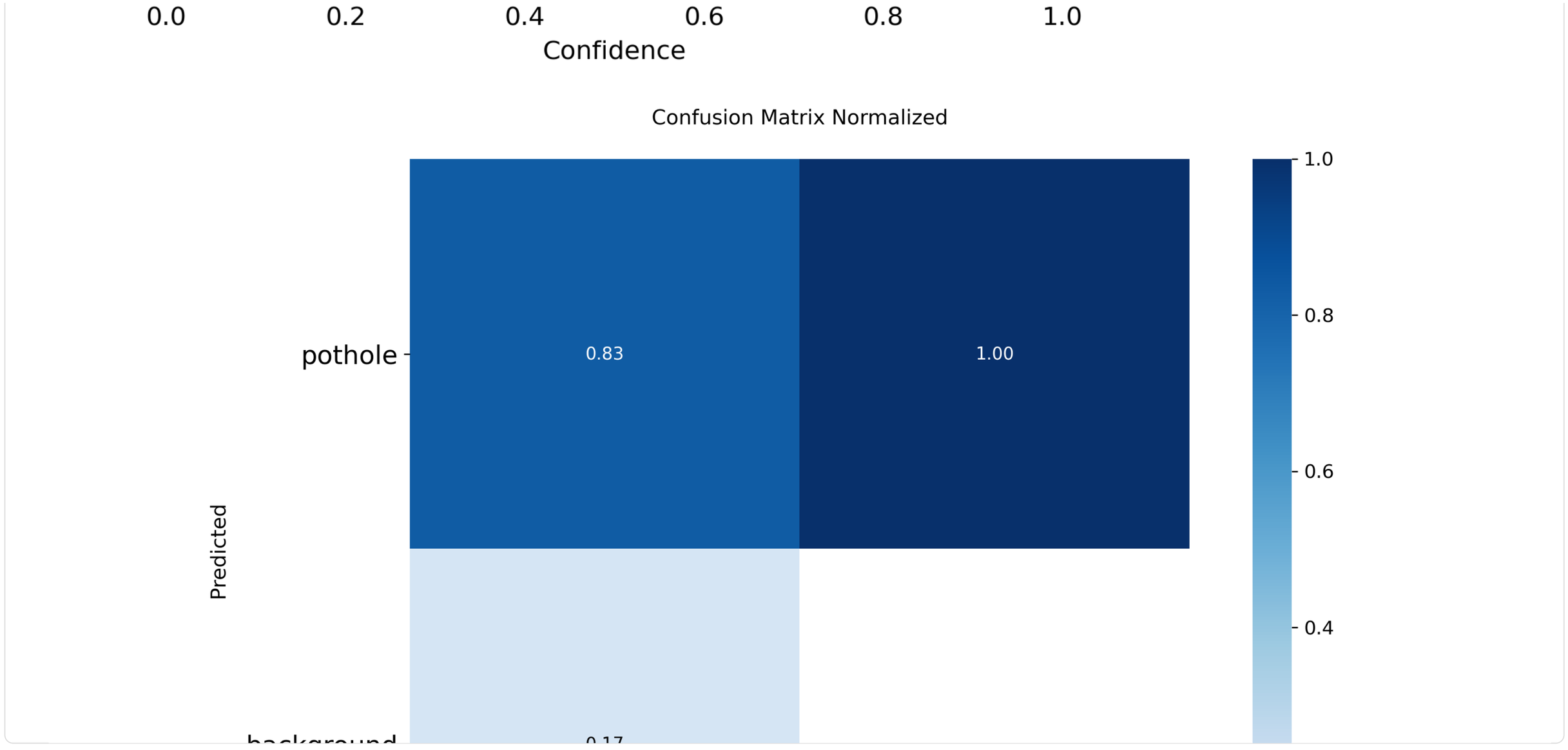

Confusion Matrix
pothole
background
309
237
63
Predicted
pothole
background
300
250
200
150
100
50
0

True


Precision-Confidence Curve
Precision
1.0
0.8
0.6
0.4
0.2
0.0
pothole
all classes 1.00 at 0.928


0.0
0.2
0.4
0.6
0.8
1.0
Confidence
F1-Confidence Curve
1.0
0.8
0.6
0.4
0.2
0.0
F1
pothole
all classes 0.75 at 0.540


0.0
0.2
0.4
0.6
0.8
1.0
Confidence
Recall-Confidence Curve
1.0
0.8
0.6
0.4
0.2
0.0
Recall
pothole
all classes 0.94 at 0.000



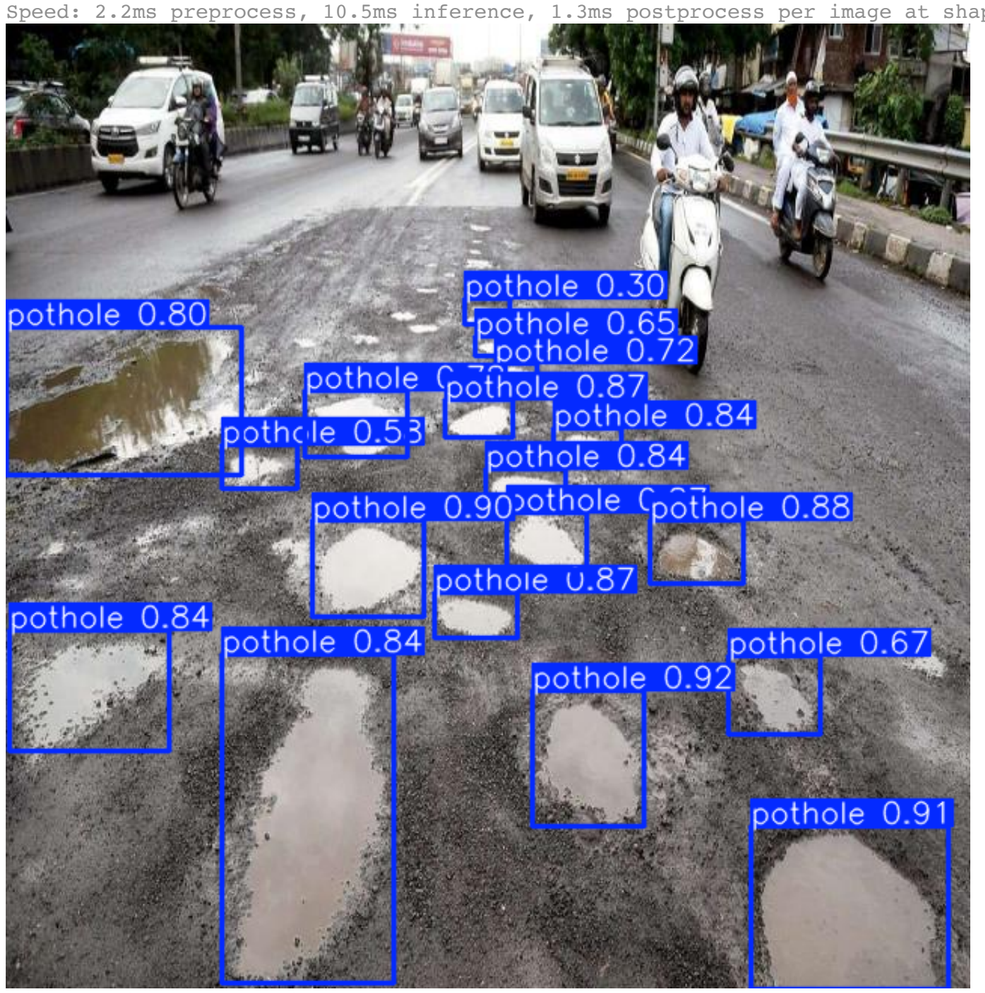

```
from google.colab import files
import os

uploaded = files.upload()
test_image = list(uploaded.keys())[0]

results = model.predict(test_image, imgsz=640)
res = results[0]

res.show()

os.makedirs("/content/test_results", exist_ok=True)
```

```
res.save("/content/test_results/result.png")
```

Choose Files 108_jpg.rf....06795d.jpg

108_jpg.rf.4e9b9dca9d6ea7afc84dbc9e4706795d.jpg(image/jpeg) - 105332 bytes, last modified: n/a - 100% done

```
Saving 108_jpg.rf.4e9b9dca9d6ea7afc84dbc9e4706795d.jpg to 108_jpg.rf.4e9b9dca9d6ea7afc84dbc9e4706795d.jpg

image 1/1 /content/108_jpg.rf.4e9b9dca9d6ea7afc84dbc9e4706795d.jpg: 640x640 18 potholes, 10.5ms
Speed: 2.2ms preprocess, 10.5ms inference, 1.3ms postprocess per image at shape (1, 3, 640, 640)
```

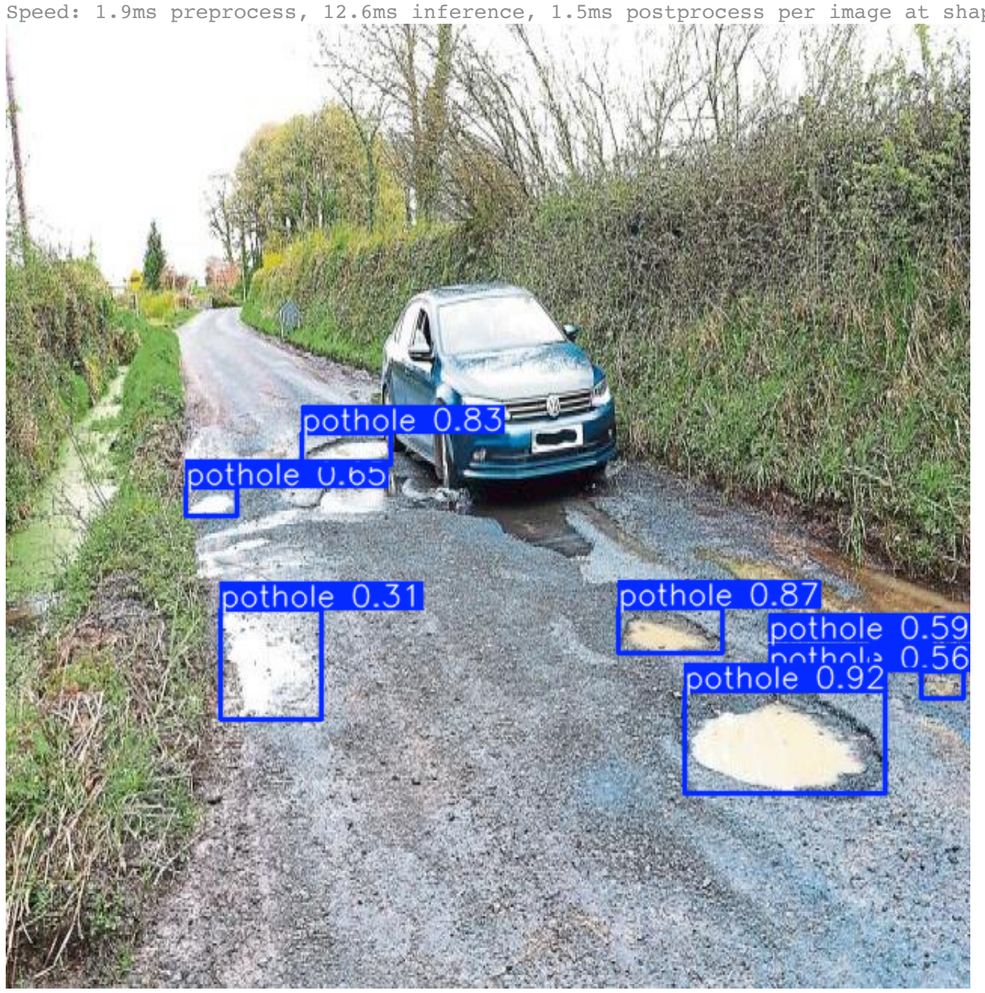



```
'/content/test_results/result.png'
```

```
from google.colab import files
import os

uploaded = files.upload()

os.makedirs("/content/test_results_batch2", exist_ok=True)

for img_name in uploaded.keys():
    results = model.predict(img_name, imgsz=640)
    res = results[0]
    res.show()
```

```
save_path = f"/content/test_results_batch2/{img_name}"
res.save(save_path)
```

Choose Files 119_jpg.rf....0860c4f.jpg

119_jpg.rf.aec2a22e68edc38dff8422d160860c4f.jpg(image/jpeg) - 140007 bytes, last modified: n/a - 100% done

```
Saving 119_jpg.rf.aec2a22e68edc38dff8422d160860c4f.jpg to 119_jpg.rf.aec2a22e68edc38dff8422d160860c4f.jpg

image 1/1 /content/119_jpg.rf.aec2a22e68edc38dff8422d160860c4f.jpg: 640x640 7 potholes, 12.6ms
Speed: 1.9ms preprocess, 12.6ms inference, 1.5ms postprocess per image at shape (1, 3, 640, 640)
```