

```
import os
import cv2
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import plotly.express as px
import plotly.graph_objects as go
import seaborn as sns
from sklearn.model_selection import train_test_split

import wandb
#wandb with API key
wandb.login(key='eb4c4a1fa7eec1ffbabc36420ba1166f797d4ac5')

wandb: W&B API key is configured. Use `wandb login --relogin` to force
relogin
wandb: WARNING If you're specifying your api key in code, ensure this
code is not shared publicly.
wandb: WARNING Consider setting the WANDB_API_KEY environment
variable, or running `wandb login` from the command line.
wandb: Appending key for api.wandb.ai to your netrc file: /root/.netrc

True

train_img_path = "/kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/train/images"
train_lbl_path = "/kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/train/labels"
valid_img_path = "/kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/valid/images"
valid_lbl_path = "/kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/valid/labels"
test_img_path = "/kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/test/images"
test_lbl_path = "/kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/train/labels"
model_path = r"C:\Users\Rishabh\Desktop\MARTIAN-LUNAR\model.pt"
data_yaml_path = r"C:\Users\Rishabh\Desktop\MARTIAN-LUNAR\data.yaml"

def load_labels(label_path):
    label_files = os.listdir(label_path)
    data = []
    classes = set()
    for file in label_files:
        with open(os.path.join(label_path, file), 'r') as f:
            lines = f.readlines()
            for line in lines:
                parts = list(map(float, line.strip().split()))
                data.append([file, *parts])
                classes.add(int(parts[0]))
```

```

    df = pd.DataFrame(data, columns=['file', 'class', 'x_center',
'y_center', 'width', 'height'])
    return df, sorted(classes)

train_labels, train_classes = load_labels(train_lbl_path)
valid_labels, valid_classes = load_labels(valid_lbl_path)
test_labels, test_classes = load_labels(test_lbl_path)

# Get unique classes
all_classes = sorted(set(train_classes + valid_classes +
test_classes))
class_names = [f'class_{i}' for i in all_classes]

print("Train Labels")
print(train_labels.head())
print("\nValidation Labels")
print(valid_labels.head())
print("\nTest Labels")
print(test_labels.head())

```

Train Labels

		file	class	x_center
0	mars_crater--21-_jpg.rf.63688e718106a9b061bb70...	0.0	0.485938	
1	mars_crater--21-_jpg.rf.63688e718106a9b061bb70...	0.0	0.149219	
2	mars_crater--21-_jpg.rf.63688e718106a9b061bb70...	0.0	0.603125	
3	mars_crater--21-_jpg.rf.63688e718106a9b061bb70...	0.0	0.221875	
4	mars_crater--21-_jpg.rf.63688e718106a9b061bb70...	0.0	0.355469	

	y_center	width	height
0	0.253906	0.040625	0.049219
1	0.290625	0.042188	0.053125
2	0.437500	0.031250	0.046875
3	0.539844	0.154688	0.212500
4	0.561719	0.060937	0.082031

Validation Labels

	file	class	x_center
0	021_png.rf.575e0f1cb87a2cc439172de15816c2cc.txt	0.0	0.197656
0.591406			
1	021_png.rf.575e0f1cb87a2cc439172de15816c2cc.txt	0.0	0.430469
0.710938			
2	021_png.rf.575e0f1cb87a2cc439172de15816c2cc.txt	0.0	0.083594
0.842969			
3	021_png.rf.575e0f1cb87a2cc439172de15816c2cc.txt	0.0	0.766406

```

0.852344
4 021_png.rf.575e0f1cb87a2cc439172de15816c2cc.txt    0.0  0.241406
0.932031

      width     height
0  0.124219  0.109375
1  0.078906  0.068750
2  0.059375  0.057813
3  0.266406  0.256250
4  0.112500  0.103906

Test Labels
              file  class  x_center
\
0  mars_crater--21-_jpg.rf.63688e718106a9b061bb70...  0.0  0.485938
1  mars_crater--21-_jpg.rf.63688e718106a9b061bb70...  0.0  0.149219
2  mars_crater--21-_jpg.rf.63688e718106a9b061bb70...  0.0  0.603125
3  mars_crater--21-_jpg.rf.63688e718106a9b061bb70...  0.0  0.221875
4  mars_crater--21-_jpg.rf.63688e718106a9b061bb70...  0.0  0.355469

      y_center     width     height
0  0.253906  0.040625  0.049219
1  0.290625  0.042188  0.053125
2  0.437500  0.031250  0.046875
3  0.539844  0.154688  0.212500
4  0.561719  0.060937  0.082031

data_yaml_content = f"""
train: {train_img_path}
val: {valid_img_path}
test: {test_img_path}
nc: {len(all_classes)}
names: {class_names}
"""

with open(data_yaml_path, 'w') as f:
    f.write(data_yaml_content)

def plot_bounding_box_distribution(labels, title):
    labels['area'] = labels['width'] * labels['height']
    fig = px.histogram(labels, x='area', nbins=50, title=title)
    fig.show()

plot_bounding_box_distribution(train_labels, 'Train Bounding Box Area Distribution')
plot_bounding_box_distribution(valid_labels, 'Validation Bounding Box Area Distribution')

```

```
plot_bounding_box_distribution(test_labels, 'Test Bounding Box Area Distribution')

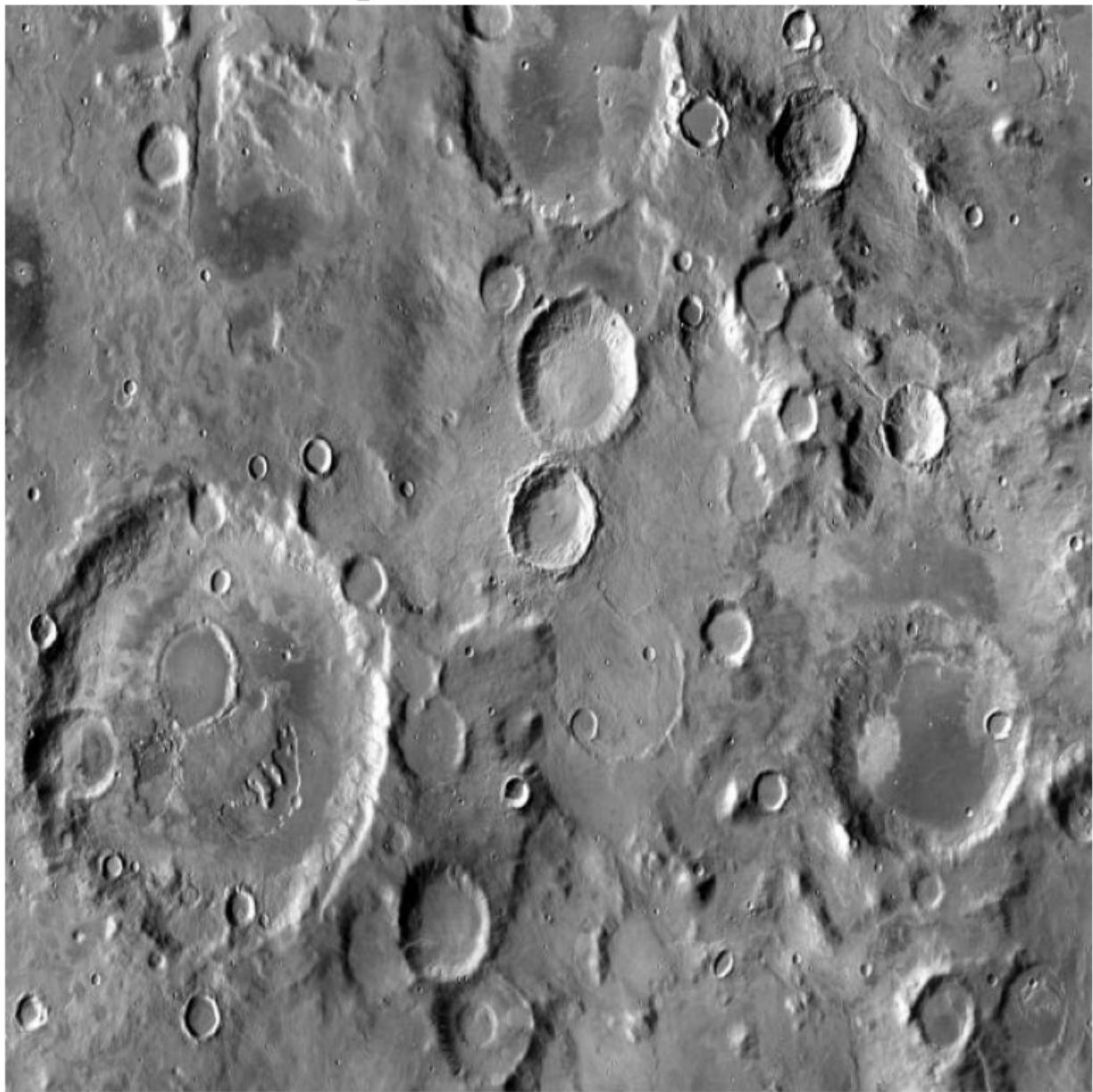
def visualize_sample_images(image_path, label_df, n_samples=5):
    image_files = os.listdir(image_path)[:n_samples]
    for img_file in image_files:
        img_path = os.path.join(image_path, img_file)
        img = cv2.imread(img_path)
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        fig, ax = plt.subplots(1, 1, figsize=(10, 10))
        ax.imshow(img)

        labels = label_df[label_df['file'] == img_file]
        for _, label in labels.iterrows():
            x_center = int(label['x_center'] * img.shape[1])
            y_center = int(label['y_center'] * img.shape[0])
            width = int(label['width'] * img.shape[1])
            height = int(label['height'] * img.shape[0])
            x_min = x_center - width // 2
            y_min = y_center - height // 2
            rect = plt.Rectangle((x_min, y_min), width, height,
edgecolor='red', facecolor='none', linewidth=2)
            ax.add_patch(rect)

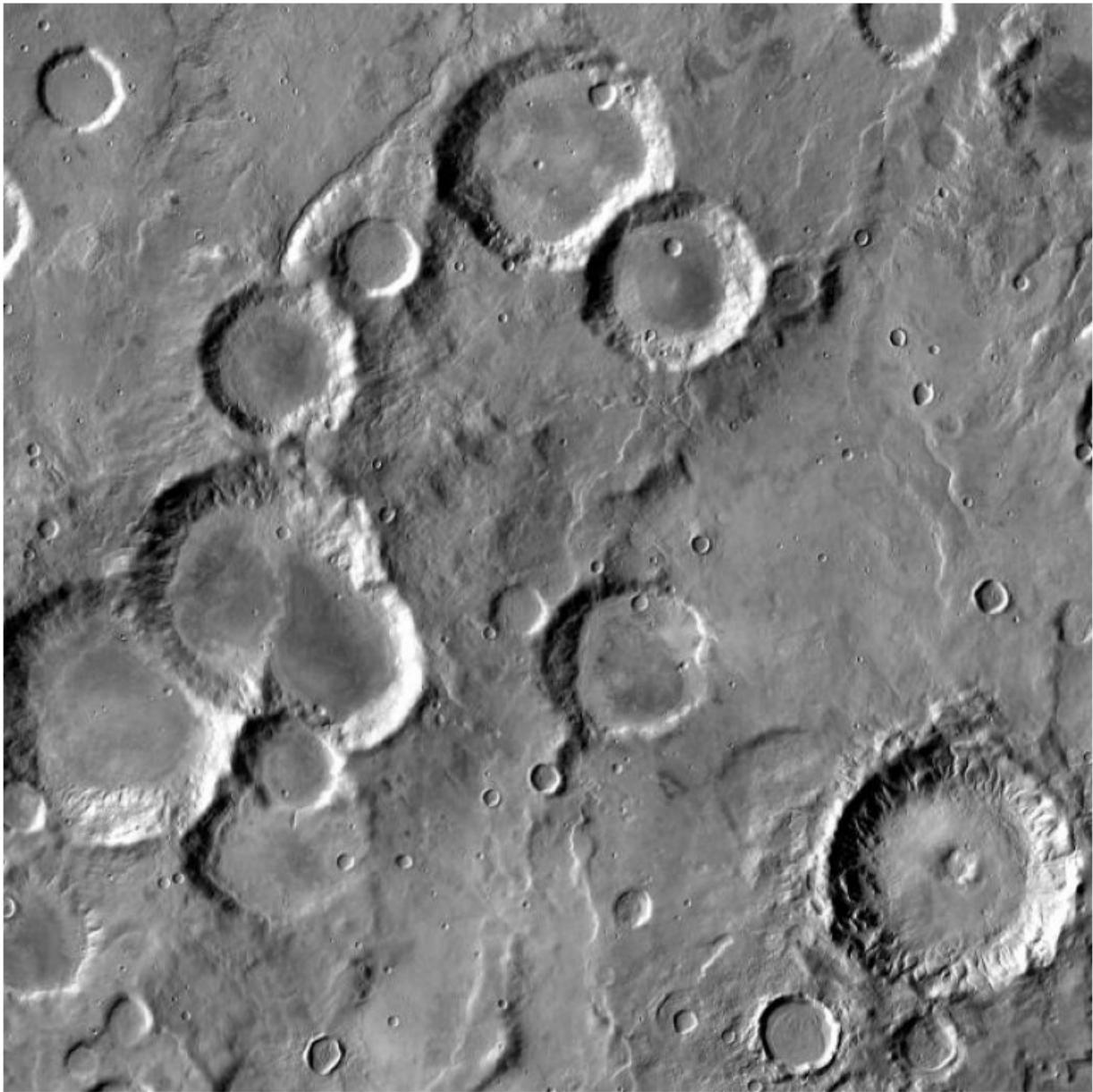
        plt.title(f'Sample Image: {img_file}')
        plt.axis('off')
        plt.show()

visualize_sample_images(train_img_path, train_labels)
visualize_sample_images(valid_img_path, valid_labels)
visualize_sample_images(test_img_path, test_labels)
```

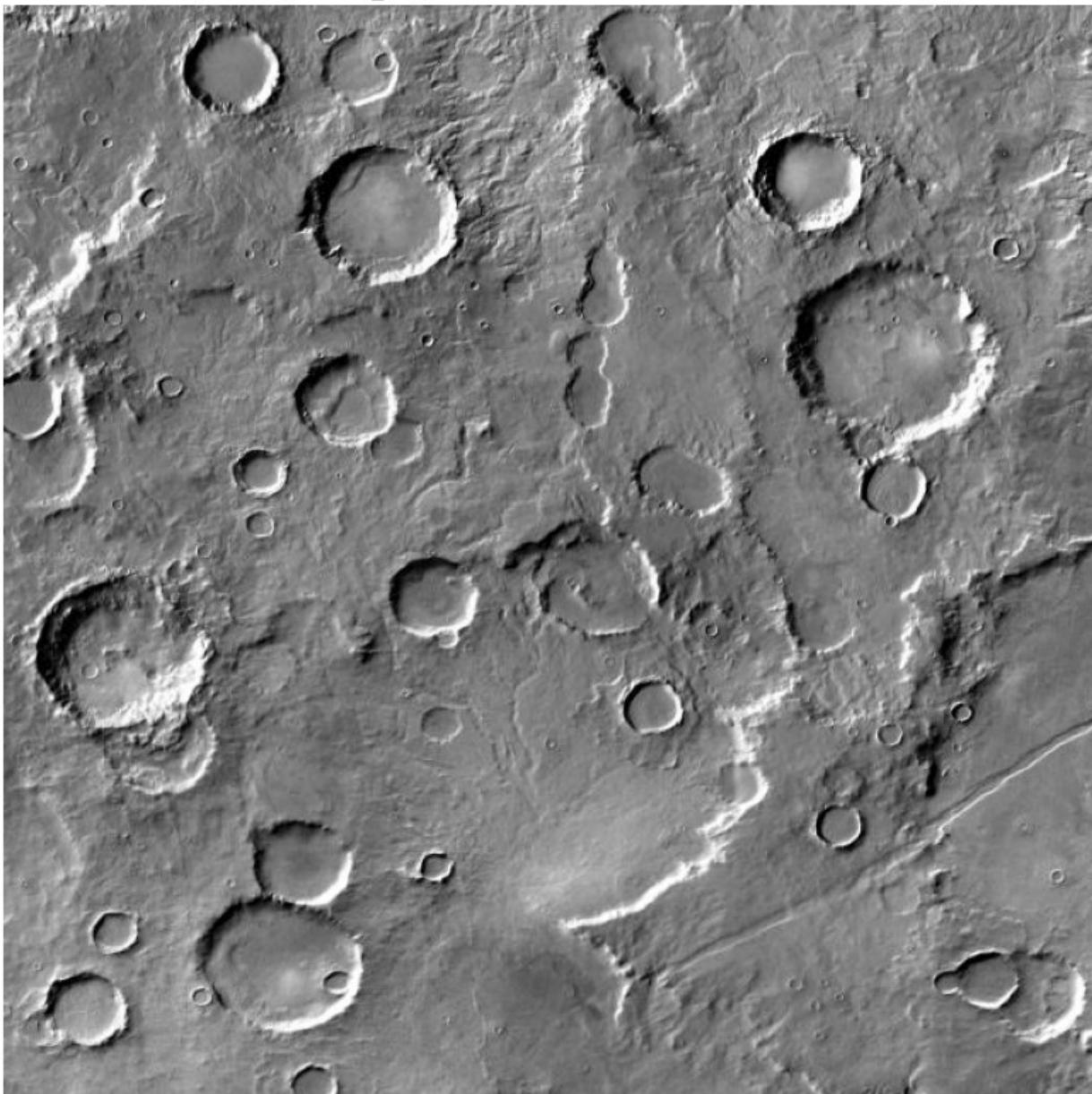
Sample Image: 03.png.rf.8f7b31e14642026833b7c0dcd1832862.jpg



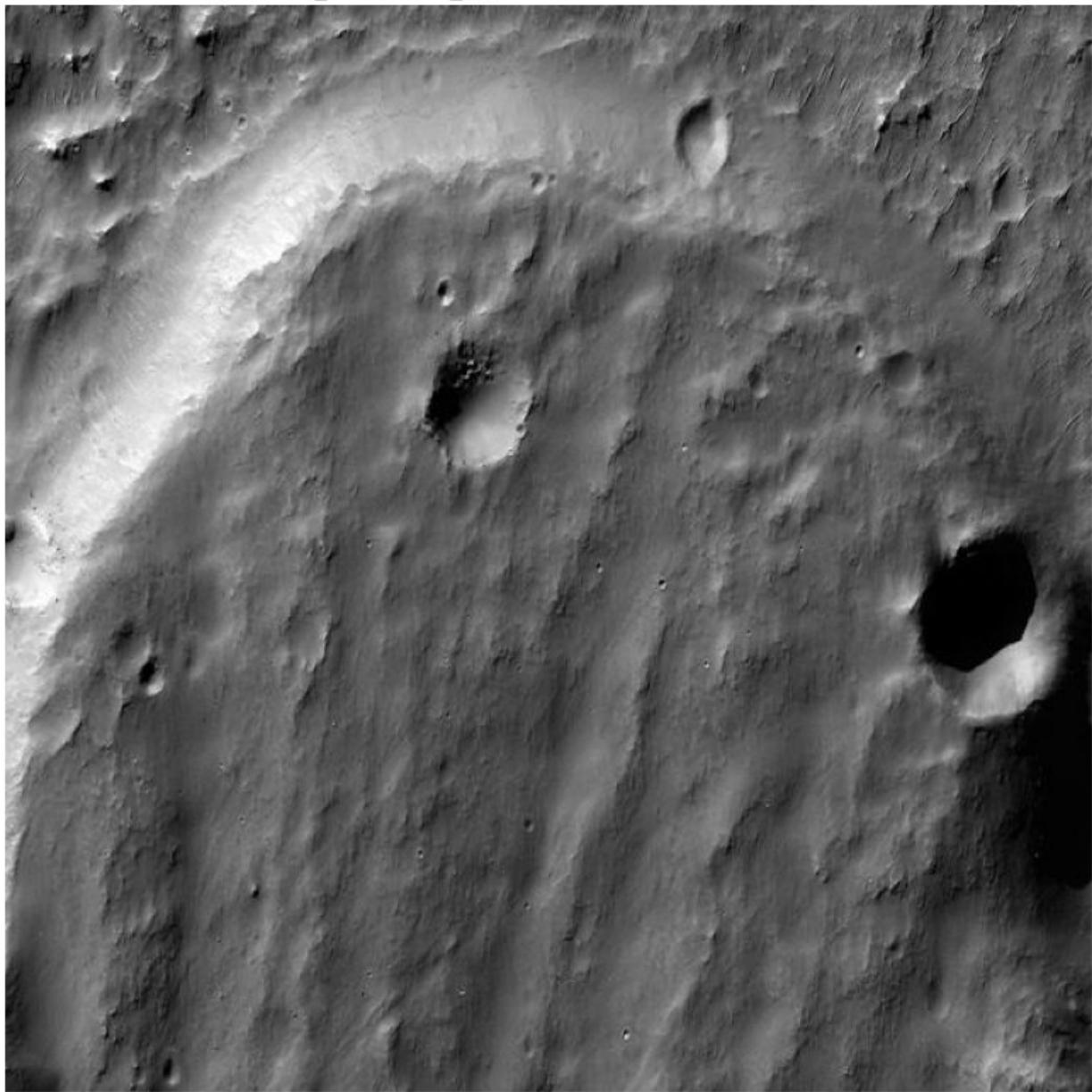
Sample Image: 016_png.rf.1973f9540ae7f672257609a8e5721ab3.jpg



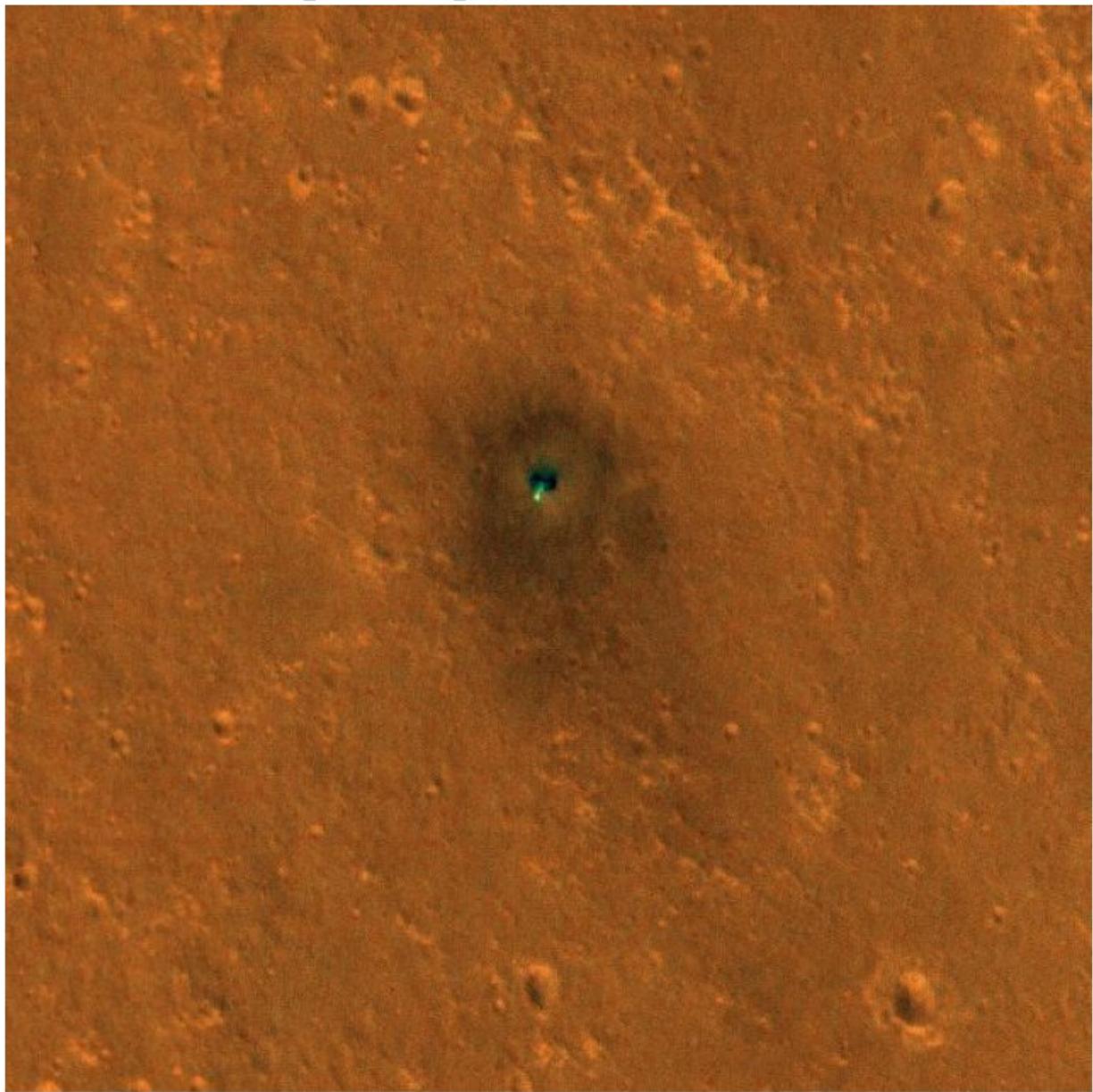
Sample Image: 018.png.rf.2d4eed5581681fe83830e51634befdaf.jpg



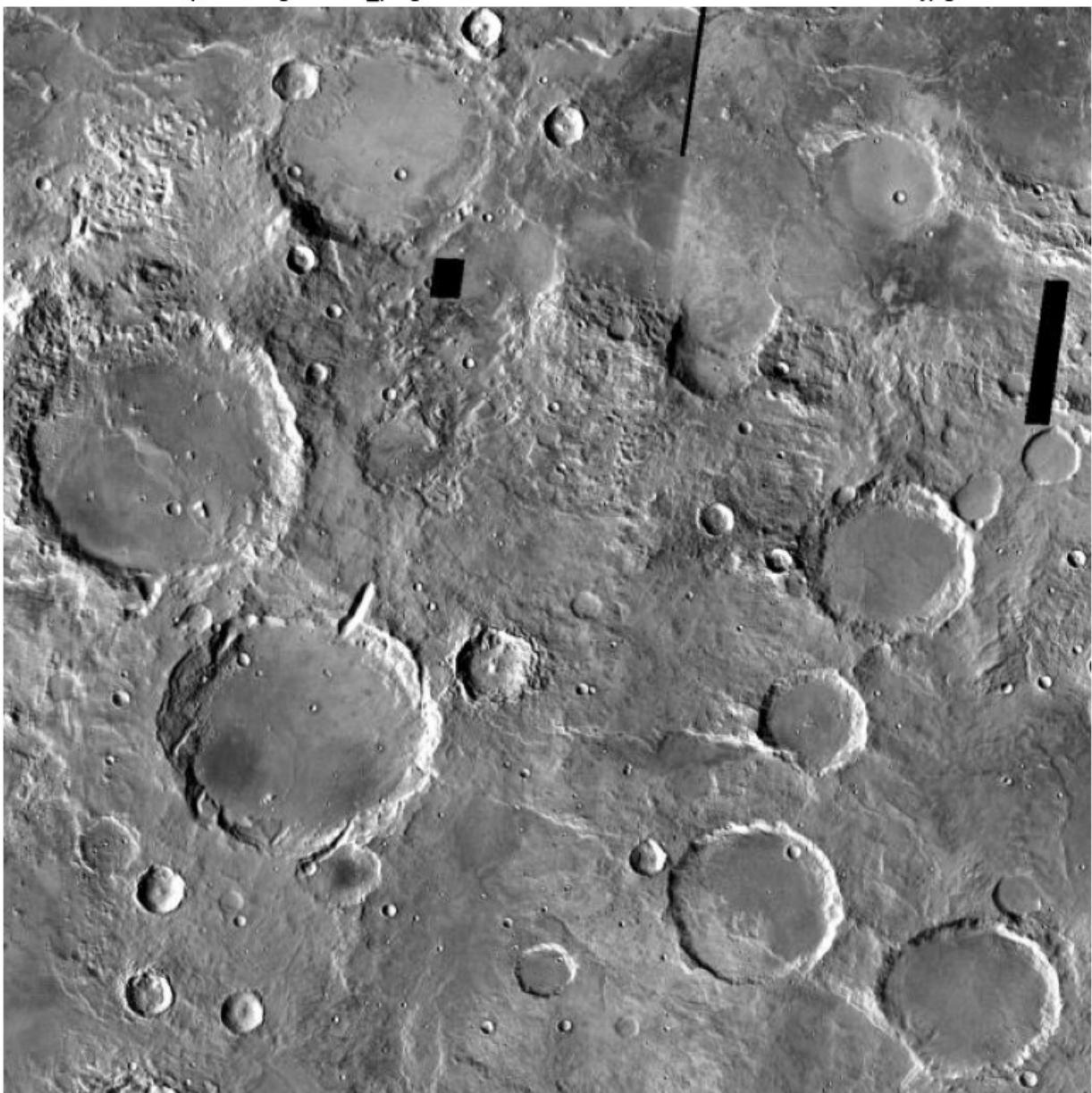
Sample Image: mars_crater--38-.jpg.rf.e6f3636efb075ba61dafa478e6b21de2.jpg



Sample Image: mars_crater--109-.jpg.rf.29afc1137114a2b872f484326254e949.jpg



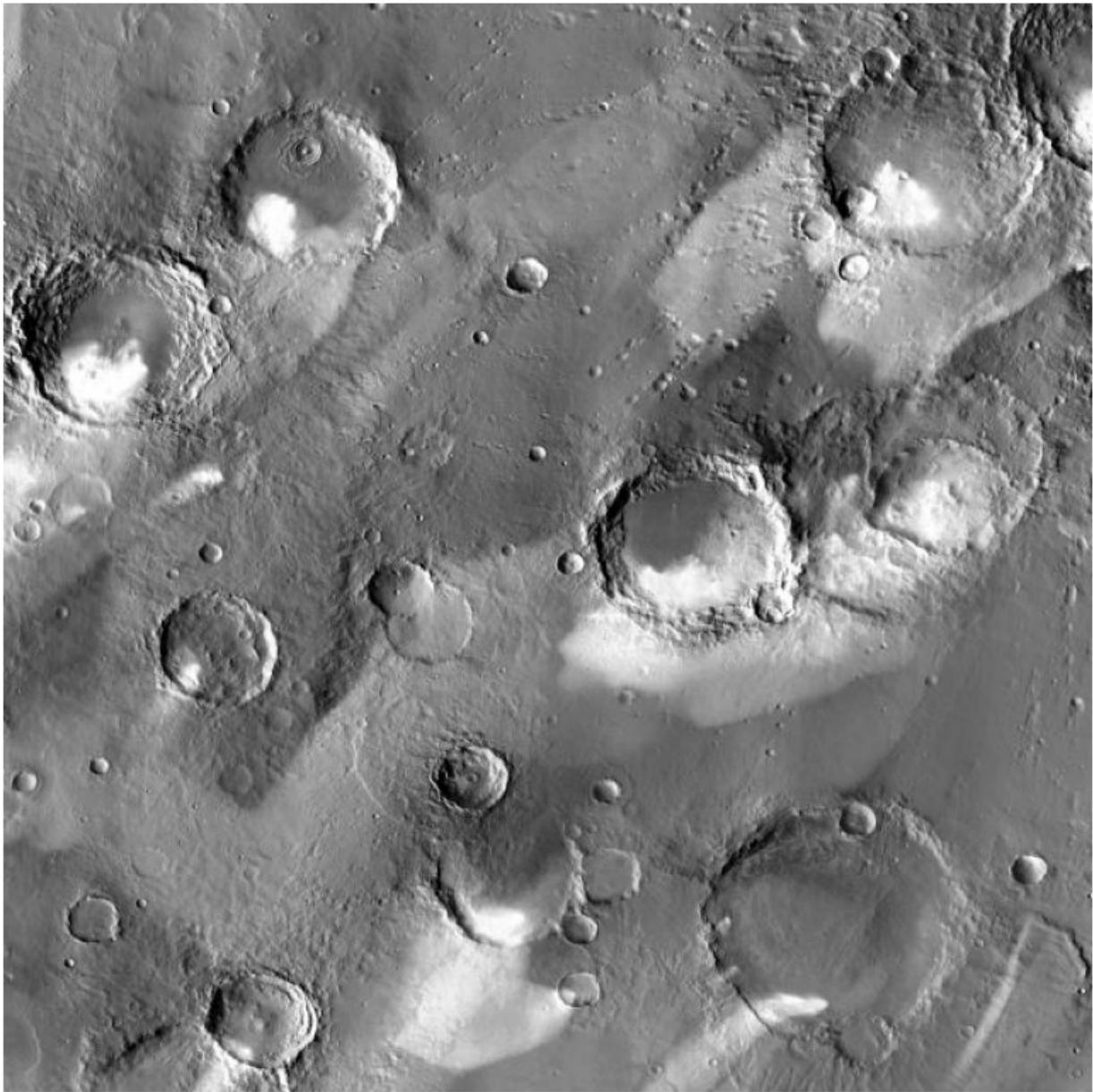
Sample Image: 023_png.rf.0a3106bdcc8e64bba283f961db77c9ec.jpg



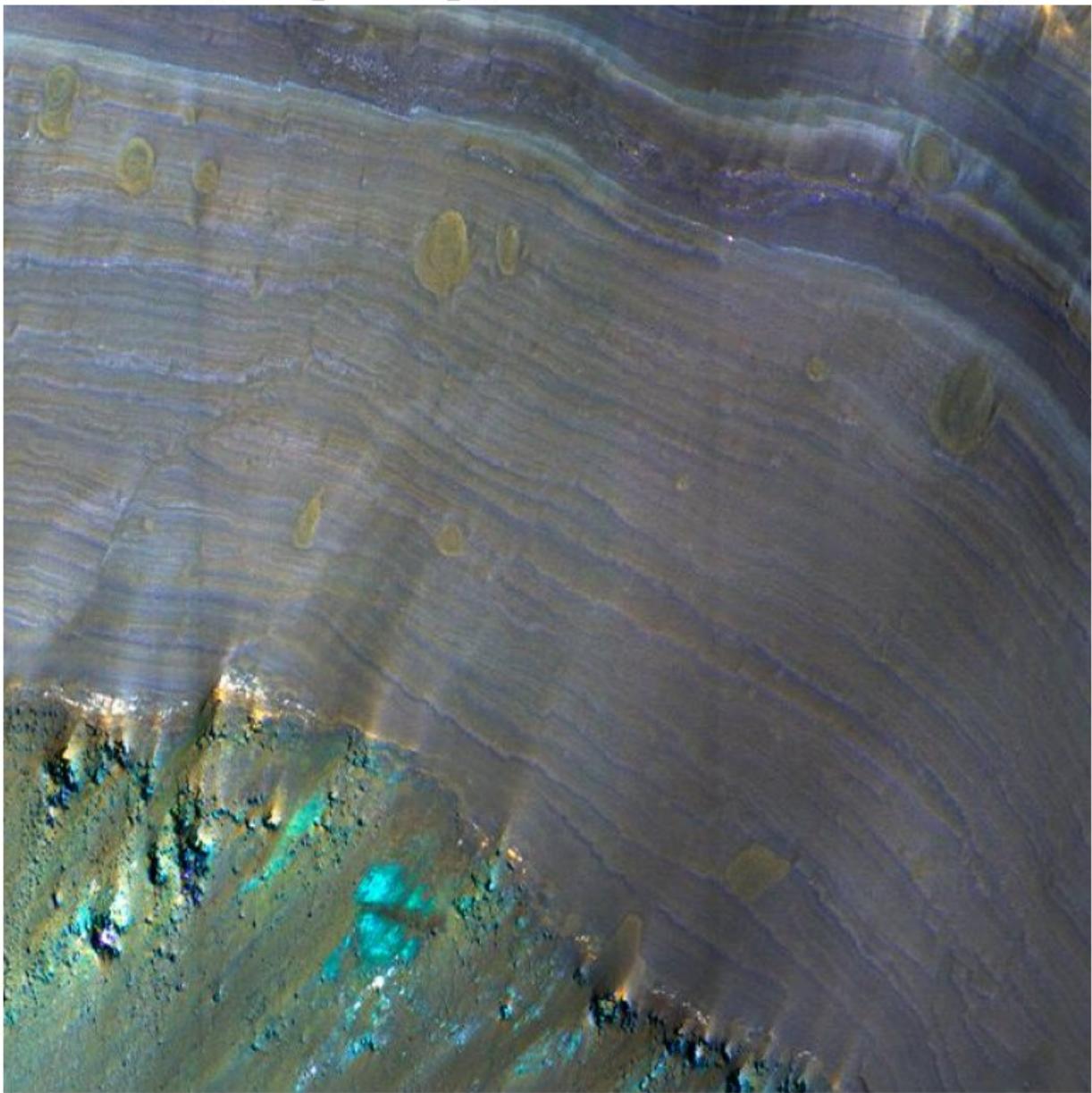
Sample Image: mars_crater-73-.jpg.rf.91d7dc2cc9ae2d5dee41207d8992c3b3.jpg



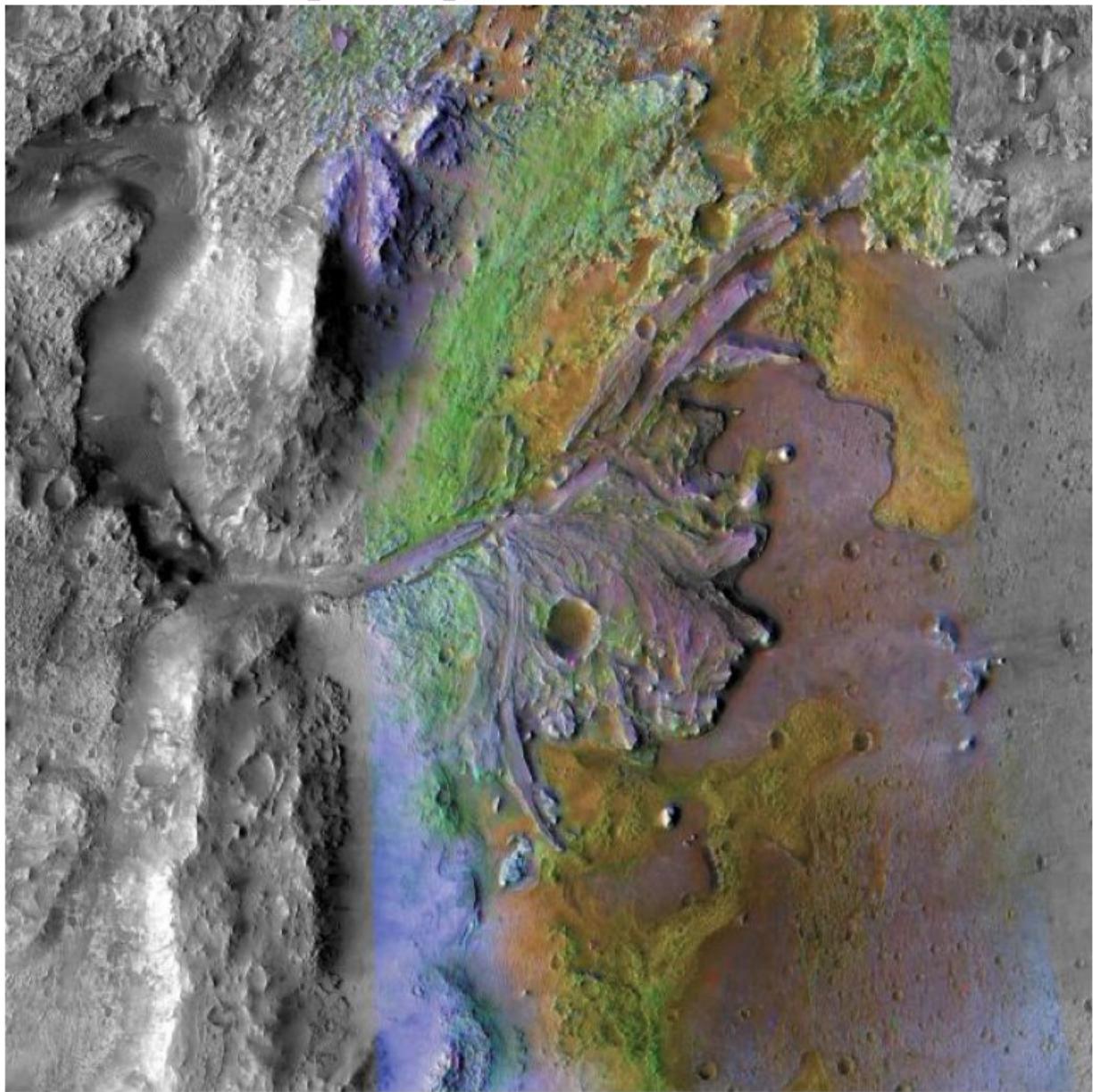
Sample Image: 021_png.rf.575e0f1cb87a2cc439172de15816c2cc.jpg



Sample Image: mars_crater--72-.jpg.rf.4e01fbde7746b57082310e11b1ff03e2.jpg



Sample Image: mars_crater-92-.jpg.rf.608e45488b76786c69755a901c1b73c9.jpg



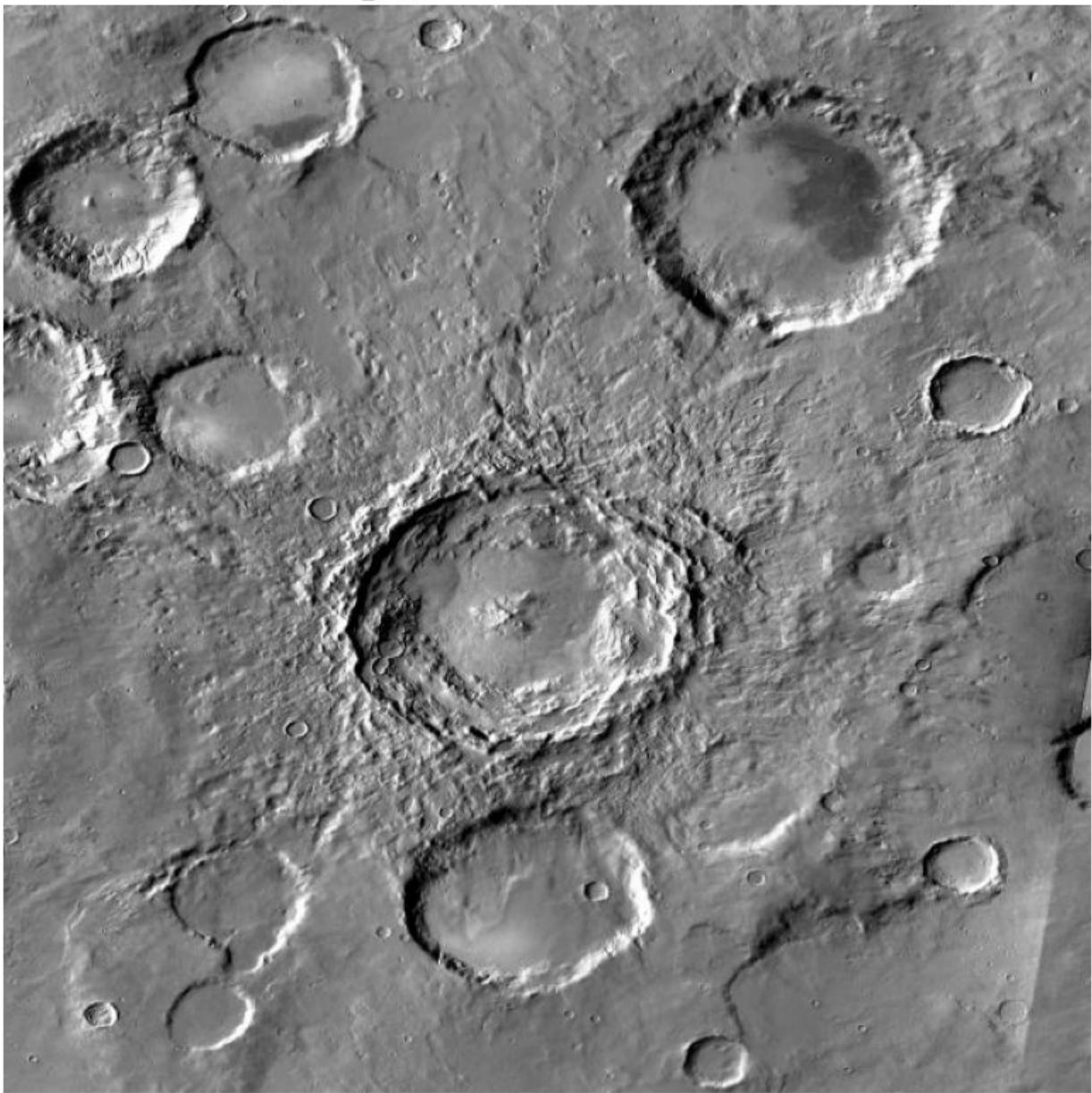
Sample Image: mars_crater--100-.jpg.rf.a2ad5867efb2d73e86d9d980ca40a9fe.jpg



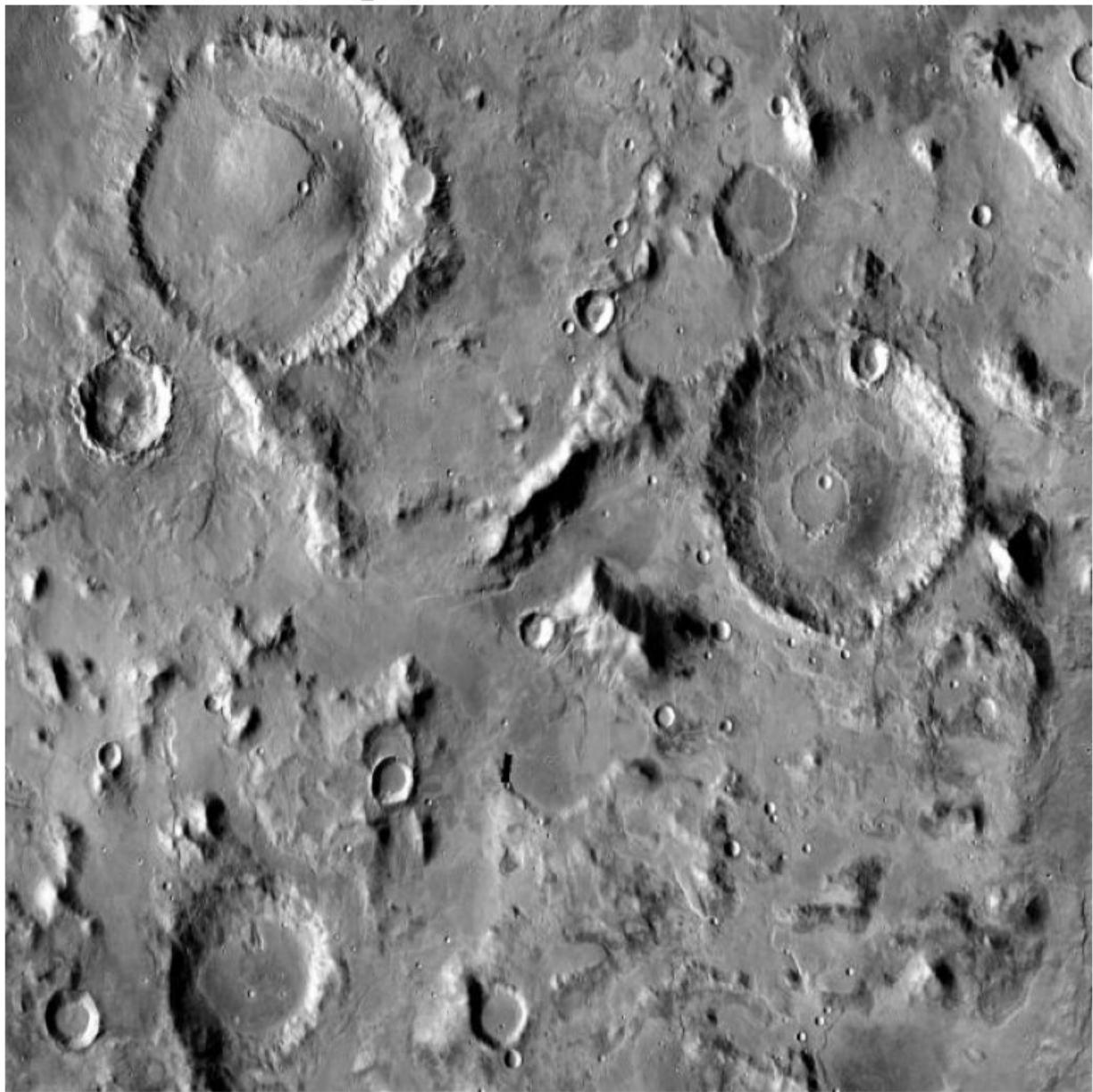
Sample Image: mars_crater--51-.jpg.rf.2f21cd1782f9da8bb8f1ada8efa134a7.jpg



Sample Image: 015_png.rf.7d5b2091b6339c9480a171a59c52c3b9.jpg



Sample Image: 04_png.rf.81a7d6cbeb9dc09e5a8ecd40e185fc92.jpg



Sample Image: mars_crater--117-.jpg.rf.b412b6593d102c5f9dda7bce79bb815c.jpg



```
!pip install -q ultralytics
from ultralytics import YOLO
model = YOLO('yolov8n.pt')

Downloading
https://github.com/ultralytics/assets/releases/download/v8.2.0/yolov8n.pt to 'yolov8n.pt'...
100%|██████████| 6.25M/6.25M [00:00<00:00, 147MB/s]
model.train(data=data_yaml_path, epochs=50)
```

```

Ultralytics YOLOv8.2.61 □ Python-3.10.13 torch-2.1.2 CUDA:0 (Tesla
P100-PCIE-16GB, 16269MiB)
engine/trainer: task=detect, mode=train, model=yolov8n.pt, data=C:\Users\Rishabh\Desktop\MARTIAN-LUNAR\data.yaml, epochs=50, time=None,
patience=100, batch=16, imgsz=640, save=True, save_period=-1,
cache=False, device=None, workers=8, project=None, name=train,
exist_ok=False, pretrained=True, optimizer=auto, verbose=True, seed=0,
deterministic=True, single_cls=False, rect=False, cos_lr=False,
close_mosaic=10, resume=False, amp=True, fraction=1.0, profile=False,
freeze=None, multi_scale=False, overlap_mask=True, mask_ratio=4,
dropout=0.0, val=True, split=val, save_json=False, save_hybrid=False,
conf=None, iou=0.7, max_det=300, half=False, dnn=False, plots=True,
source=None, vid_stride=1, stream_buffer=False, visualize=False,
augment=False, agnostic_nms=False, classes=None, retina_masks=False,
embed=None, show=False, save_frames=False, save_txt=False,
save_conf=False, save_crop=False, show_labels=True, show_conf=True,
show_boxes=True, line_width=None, format=torchscript, keras=False,
optimize=False, int8=False, dynamic=False, simplify=False, opset=None,
workspace=4, nms=False, lr0=0.01, lrf=0.01, momentum=0.937,
weight_decay=0.0005, warmup_epochs=3.0, warmup_momentum=0.8,
warmup_bias_lr=0.1, box=7.5, cls=0.5, df=1.5, pose=12.0, kobj=1.0,
label_smoothing=0.0, nbs=64, hsv_h=0.015, hsv_s=0.7, hsv_v=0.4,
degrees=0.0, translate=0.1, scale=0.5, shear=0.0, perspective=0.0,
flipud=0.0, fliplr=0.5, bgr=0.0, mosaic=1.0, mixup=0.0,
copy_paste=0.0, auto_augment=randaugment, erasing=0.4,
crop_fraction=1.0, cfg=None, tracker=botsort.yaml,
save_dir=runs/detect/train
Downloading https://ultralytics.com/assets/Arial.ttf to
'/root/.config/Ultralytics/Arial.ttf'...

```

```

100%|██████████| 755k/755k [00:00<00:00, 37.7MB/s]
2024-07-21 18:16:14,313    INFO util.py:124 -- Outdated packages:
    ipywidgets==7.7.1 found, needs ipywidgets>=8
Run `pip install -U ipywidgets`, then restart the notebook server for
rich notebook output.
2024-07-21 18:16:15,091    INFO util.py:124 -- Outdated packages:
    ipywidgets==7.7.1 found, needs ipywidgets>=8
Run `pip install -U ipywidgets`, then restart the notebook server for
rich notebook output.

```

Overriding model.yaml nc=80 with nc=1

	from	n	params	module
arguments				
0		-1	1	464 ultralytics.nn.modules.conv.Conv
[3, 16, 3, 2]		-1	1	4672 ultralytics.nn.modules.conv.Conv
1		-1	1	7360 ultralytics.nn.modules.block.C2f
[16, 32, 3, 2]		-1	1	
2		-1	1	
[32, 32, 1, True]				

```

3           -1  1      18560 ultralytics.nn.modules.conv.Conv
[32, 64, 3, 2]
4           -1  2      49664 ultralytics.nn.modules.block.C2f
[64, 64, 2, True]
5           -1  1      73984 ultralytics.nn.modules.conv.Conv
[64, 128, 3, 2]
6           -1  2     197632 ultralytics.nn.modules.block.C2f
[128, 128, 2, True]
7           -1  1     295424 ultralytics.nn.modules.conv.Conv
[128, 256, 3, 2]
8           -1  1     460288 ultralytics.nn.modules.block.C2f
[256, 256, 1, True]
9           -1  1     164608
ultralytics.nn.modules.block.SPPF           [256, 256, 5]

10          -1  1      0
torch.nn.modules.upsampling.Upsample        [None, 2, 'nearest']

11          [-1, 6] 1      0
ultralytics.nn.modules.conv.Concat          [1]

12          -1  1     148224 ultralytics.nn.modules.block.C2f
[384, 128, 1]
13          -1  1      0
torch.nn.modules.upsampling.Upsample        [None, 2, 'nearest']

14          [-1, 4] 1      0
ultralytics.nn.modules.conv.Concat          [1]

15          -1  1     37248 ultralytics.nn.modules.block.C2f
[192, 64, 1]
16          -1  1     36992 ultralytics.nn.modules.conv.Conv
[64, 64, 3, 2]
17          [-1, 12] 1      0
ultralytics.nn.modules.conv.Concat          [1]

18          -1  1     123648 ultralytics.nn.modules.block.C2f
[192, 128, 1]
19          -1  1     147712 ultralytics.nn.modules.conv.Conv
[128, 128, 3, 2]
20          [-1, 9] 1      0
ultralytics.nn.modules.conv.Concat          [1]

21          -1  1     493056 ultralytics.nn.modules.block.C2f
[384, 256, 1]
22          [15, 18, 21] 1    751507
ultralytics.nn.modules.head.Detect         [1, [64, 128, 256]]

```

Model summary: 225 layers, 3,011,043 parameters, 3,011,027 gradients,
8.2 GFLOPs

```
Transferred 319/355 items from pretrained weights
TensorBoard: Start with 'tensorboard --logdir runs/detect/train', view
at http://localhost:6006/

wandb: Currently logged in as:faf2001f (faf2001f-university-of-
engineering-and-technology-taxila). Use `wandb login --relogin` to
force relogin

<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>

Freezing layer 'model.22.dfl.conv.weight'
AMP: running Automatic Mixed Precision (AMP) checks with YOL0v8n...
AMP: checks passed □

train: Scanning /kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/train/labels... 98 images, 9 backgrounds, 0 corrupt:
100%|██████████| 98/98 [00:00<00:00, 344.47it/s]

train: WARNING △ Cache directory /kaggle/input/martian-lunar-craters-
dataset/MARTIAN-LUNAR/craters/train is not writeable, cache not saved.

albumentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01,
blur_limit=(3, 7)), ToGray(p=0.01), CLAHE(p=0.01, clip_limit=(1, 4.0),
tile_grid_size=(8, 8))

/opt/conda/lib/python3.10/multiprocessing/popen_fork.py:66:
RuntimeWarning:

os.fork() was called. os.fork() is incompatible with multithreaded
code, and JAX is multithreaded, so this will likely lead to a
deadlock.

val: Scanning /kaggle/input/martian-lunar-craters-dataset/MARTIAN-
LUNAR/craters/valid/labels... 26 images, 2 backgrounds, 0 corrupt:
100%|██████████| 26/26 [00:00<00:00, 340.95it/s]

val: WARNING △ Cache directory /kaggle/input/martian-lunar-craters-
dataset/MARTIAN-LUNAR/craters/valid is not writeable, cache not saved.
```

```
Plotting labels to runs/detect/train/labels.jpg...
optimizer: 'optimizer=auto' found, ignoring 'lr0=0.01' and
'momentum=0.937' and determining best 'optimizer', 'lr0' and
'momentum' automatically...
optimizer: AdamW(lr=0.002, momentum=0.9) with parameter groups 57
weight(decay=0.0), 64 weight(decay=0.0005), 63 bias(decay=0.0)
TensorBoard: model graph visualization added □
Image sizes 640 train, 640 val
Using 4 dataloader workers
Logging results to runs/detect/train
Starting training for 50 epochs...
```

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					
1/50	2.56G	1.939	3.479	1.46	55
640: 100%	[██████████ 7/7 [00:05<00:00, 1.32it/s]	Class	Images	Instances	Box(P R
mAP50 mAP50-95): 100%	[██████████ 1/1 [00:01<00:00, 1.28s/it]				
	all	26	202	0.0128	0.495
0.0759	0.0302				

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					
2/50	2.36G	1.662	2.871	1.331	18
640: 100%	[██████████ 7/7 [00:01<00:00, 4.94it/s]	Class	Images	Instances	Box(P R
mAP50 mAP50-95): 100%	[██████████ 1/1 [00:00<00:00, 4.66it/s]				
	all	26	202	0.0208	0.802
0.155	0.0817				

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					
3/50	2.42G	1.532	1.782	1.277	11
640: 100%	[██████████ 7/7 [00:01<00:00, 5.64it/s]	Class	Images	Instances	Box(P R
mAP50 mAP50-95): 100%	[██████████ 1/1 [00:00<00:00, 5.46it/s]				
	all	26	202	0.0224	0.866
0.27	0.153				

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	4/50	2.49G	1.605	1.66	1.196	12
640:	100%	[██████████ 7/7 [00:01<00:00, 5.86it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.37it/s]				R
		all	26	202	0.0212	0.817
0.335	0.186					
	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size	5/50	2.42G	1.519	2.293	1.302	2
640:	100%	[██████████ 7/7 [00:01<00:00, 5.60it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.35it/s]				R
		all	26	202	0.926	0.0625
0.369	0.222					
	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size	6/50	2.43G	1.403	1.427	1.152	27
640:	100%	[██████████ 7/7 [00:01<00:00, 5.84it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.72it/s]				R
		all	26	202	0.881	0.147
0.399	0.211					
	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size	7/50	2.58G	1.548	1.555	1.279	11
640:	100%	[██████████ 7/7 [00:01<00:00, 5.68it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 4.93it/s]				R
		all	26	202	0.863	0.0936
0.333	0.167					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	8/50	2.42G	1.513	1.488	1.203	63
640:	100%	[██████████ 7/7 [00:01<00:00, 5.96it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.60it/s]				
		all	26	202	0.294	0.158
0.178	0.0889					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	9/50	2.37G	1.475	1.551	1.177	5
640:	100%	[██████████ 7/7 [00:01<00:00, 5.73it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.16it/s]				
		all	26	202	0.606	0.183
0.291	0.163					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	10/50	2.44G	1.474	1.53	1.211	39
640:	100%	[██████████ 7/7 [00:01<00:00, 5.83it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.25it/s]				
		all	26	202	0.472	0.203
0.284	0.163					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	11/50	2.41G	1.463	1.463	1.23	31
640:	100%	[██████████ 7/7 [00:01<00:00, 5.96it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.11it/s]				
		all	26	202	0.57	0.27
0.377	0.23					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	12/50	2.42G	1.418	1.357	1.188	44
640:	100%	[██████████ 7/7 [00:01<00:00, 5.83it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.38it/s]				

		all	26	202	0.331	0.361
0.297	0.171					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
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640:	13/50	2.42G	1.396	1.366	1.162	45
	100%	[██████████ 7/7 [00:01<00:00, 6.13it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.07it/s]			R

		all	26	202	0.138	0.248
0.0999	0.0507					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
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640:	14/50	2.43G	1.496	1.572	1.218	6
	100%	[██████████ 7/7 [00:01<00:00, 5.82it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 4.99it/s]			R

		all	26	202	0.178	0.272
0.133	0.0713					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
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640:	15/50	2.43G	1.554	1.427	1.253	27
	100%	[██████████ 7/7 [00:01<00:00, 5.89it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 4.60it/s]			R

		all	26	202	0.241	0.315
0.184	0.0967					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
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640:	16/50	2.44G	1.47	1.429	1.237	8
	100%	[██████████ 7/7 [00:01<00:00, 6.02it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.57it/s]			R

		all	26	202	0.265	0.302
0.214	0.115					
<hr/>						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
17/50	2.45G	1.431	1.361	1.179		9
640: 100% ██████████ 7/7 [00:01<00:00, 6.08it/s]	Class	Images	Instances	Box(P	R	
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.46it/s]						
		all	26	202	0.527	0.312
0.388	0.231					
<hr/>						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
18/50	2.44G	1.417	1.354	1.2		16
640: 100% ██████████ 7/7 [00:01<00:00, 5.94it/s]	Class	Images	Instances	Box(P	R	
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 4.80it/s]						
		all	26	202	0.629	0.54
0.589	0.328					
<hr/>						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
19/50	2.4G	1.362	1.289	1.159		27
640: 100% ██████████ 7/7 [00:01<00:00, 5.88it/s]	Class	Images	Instances	Box(P	R	
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 4.71it/s]						
		all	26	202	0.654	0.515
0.587	0.328					
<hr/>						
Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances	Size
20/50	2.51G	1.384	1.264	1.158		28
640: 100% ██████████ 7/7 [00:01<00:00, 5.94it/s]	Class	Images	Instances	Box(P	R	
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 4.90it/s]						
		all	26	202	0.627	0.594
0.612	0.345					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	21/50	2.41G	1.444	1.321	1.178	9
640:	100%	[██████████ 7/7 [00:01<00:00, 6.13it/s]				
		Class	Images	Instances	Box(P	R
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 4.90it/s]			
			all	26	202	0.577
0.599		0.33				0.579

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	22/50	2.44G	1.282	1.172	1.122	11
640:	100%	[██████████ 7/7 [00:01<00:00, 6.05it/s]				
		Class	Images	Instances	Box(P	R
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.52it/s]			
			all	26	202	0.537
0.559		0.299				0.564

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	23/50	2.36G	1.388	1.229	1.166	26
640:	100%	[██████████ 7/7 [00:01<00:00, 5.95it/s]				
		Class	Images	Instances	Box(P	R
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.12it/s]			
			all	26	202	0.525
0.52		0.267				0.574

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	24/50	2.42G	1.38	1.229	1.148	35
640:	100%	[██████████ 7/7 [00:01<00:00, 5.98it/s]				
		Class	Images	Instances	Box(P	R
mAP50	mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.96it/s]			
			all	26	202	0.503
0.533		0.27				0.584

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	25/50	2.55G	1.276	1.161	1.121	19
640:	100%	[██████████ 7/7 [00:01<00:00, 6.08it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.48it/s]				
		all	26	202	0.529	0.599
0.553	0.291					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	26/50	2.37G	1.36	1.223	1.156	11
640:	100%	[██████████ 7/7 [00:01<00:00, 6.03it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.04it/s]				
		all	26	202	0.576	0.683
0.625	0.341					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	27/50	2.36G	1.319	1.189	1.124	21
640:	100%	[██████████ 7/7 [00:01<00:00, 5.94it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.47it/s]				
		all	26	202	0.615	0.593
0.627	0.34					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	28/50	2.42G	1.29	1.096	1.086	34
640:	100%	[██████████ 7/7 [00:01<00:00, 5.91it/s]	Class	Images	Instances	Box(P R
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.27it/s]				
		all	26	202	0.602	0.609
0.617	0.337					
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances

29/50	2.37G	1.388	1.425	1.212	4
640: 100% ██████████ 7/7 [00:01<00:00, 5.96it/s]	Class	Images	Instances	Box(P)	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.69it/s]					

	all	26	202	0.618	0.629
0.647	0.36				

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

30/50	2.37G	1.327	1.12	1.122	27
640: 100% ██████████ 7/7 [00:01<00:00, 5.98it/s]	Class	Images	Instances	Box(P)	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.45it/s]					

	all	26	202	0.635	0.698
0.679	0.382				

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

31/50	2.43G	1.259	1.086	1.103	23
640: 100% ██████████ 7/7 [00:01<00:00, 5.94it/s]	Class	Images	Instances	Box(P)	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.44it/s]					

	all	26	202	0.609	0.693
0.653	0.358				

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

32/50	2.53G	1.262	1.081	1.117	9
640: 100% ██████████ 7/7 [00:01<00:00, 5.97it/s]	Class	Images	Instances	Box(P)	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.17it/s]					

	all	26	202	0.568	0.693
0.628	0.33				

Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

33/50	2.44G	1.261	1.06	1.091	19
640: 100% ██████████ 7/7 [00:01<00:00, 6.09it/s]	Class	Images	Instances	Box(P)	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.99it/s]					

		all	26	202	0.563	0.688
0.624	0.325					
<hr/>						
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	34/50	2.41G	1.27	1.004	1.076	39
640:	100%	[██████████ 7/7 [00:01<00:00, 6.03it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.19it/s]	R			
		all	26	202	0.612	0.649
0.661	0.356					
<hr/>						
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	35/50	2.36G	1.255	1.074	1.1	22
640:	100%	[██████████ 7/7 [00:01<00:00, 5.92it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.73it/s]	R			
		all	26	202	0.684	0.589
0.674	0.379					
<hr/>						
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	36/50	2.37G	1.226	1.127	1.102	20
640:	100%	[██████████ 7/7 [00:01<00:00, 6.09it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.35it/s]	R			
		all	26	202	0.646	0.604
0.66	0.379					
<hr/>						
Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	37/50	2.43G	1.168	1.007	1.084	25
640:	100%	[██████████ 7/7 [00:01<00:00, 6.06it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.37it/s]	R			

		all	26	202	0.613	0.634
0.673	0.396					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	38/50	2.42G	1.2	1.021	1.08	18
640:	100%	[██████████ 7/7 [00:01<00:00, 5.96it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.33it/s]				R
		all	26	202	0.626	0.688
0.71	0.413					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	39/50	2.41G	1.2	0.9858	1.101	23
640:	100%	[██████████ 7/7 [00:01<00:00, 6.04it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.63it/s]				R
		all	26	202	0.621	0.673
0.715	0.4					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	40/50	2.37G	1.18	0.9846	1.072	14
640:	100%	[██████████ 7/7 [00:01<00:00, 5.97it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.68it/s]				R
		all	26	202	0.638	0.634
0.698	0.385					

Closing dataloader mosaic
albumentations: Blur(p=0.01, blur_limit=(3, 7)), MedianBlur(p=0.01, blur_limit=(3, 7)), ToGray(p=0.01), CLAHE(p=0.01, clip_limit=(1, 4.0), tile_grid_size=(8, 8))

/opt/conda/lib/python3.10/multiprocessing/popen_fork.py:66:
RuntimeWarning:

os.fork() was called. os.fork() is incompatible with multithreaded code, and JAX is multithreaded, so this will likely lead to a deadlock.

```
/opt/conda/lib/python3.10/multiprocessing/popen_fork.py:66:  
RuntimeWarning:
```

```
os.fork() was called. os.fork() is incompatible with multithreaded  
code, and JAX is multithreaded, so this will likely lead to a  
deadlock.
```

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	41/50	2.43G	1.317	1.137	1.153	5
640:	100%	[██████████ 7/7 [00:03<00:00, 1.87it/s]	Class	Images	Instances	Box(P
mAP50 mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 4.68it/s]	R			
		all	26	202	0.622	0.668
	0.692	0.388				

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	42/50	2.37G	1.212	1.065	1.058	19
640:	100%	[██████████ 7/7 [00:01<00:00, 6.02it/s]	Class	Images	Instances	Box(P
mAP50 mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.70it/s]	R			
		all	26	202	0.617	0.677
	0.698	0.36				

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	43/50	2.43G	1.257	1.21	1.165	3
640:	100%	[██████████ 7/7 [00:01<00:00, 5.91it/s]	Class	Images	Instances	Box(P
mAP50 mAP50-95):	100%	[██████████ 1/1 [00:00<00:00, 5.38it/s]	R			
		all	26	202	0.615	0.624
	0.67	0.36				

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
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44/50	2.43G	1.233	1.031	1.127	12
640: 100% ██████████ 7/7 [00:01<00:00, 5.96it/s]	Class	Images	Instances	Box(P	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.90it/s]					

0.648	0.348	all	26	202	0.706	0.554
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Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

45/50	2.42G	1.191	1.085	1.047	12
640: 100% ██████████ 7/7 [00:01<00:00, 6.27it/s]	Class	Images	Instances	Box(P	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.15it/s]					

0.645	0.356	all	26	202	0.739	0.554
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Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

46/50	2.43G	1.209	1.009	1.089	12
640: 100% ██████████ 7/7 [00:01<00:00, 6.10it/s]	Class	Images	Instances	Box(P	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.79it/s]					

0.658	0.367	all	26	202	0.736	0.545
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Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

47/50	2.36G	1.147	0.944	1.054	9
640: 100% ██████████ 7/7 [00:01<00:00, 6.04it/s]	Class	Images	Instances	Box(P	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.87it/s]					

0.67	0.378	all	26	202	0.643	0.639
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Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
Size					

48/50	2.45G	1.17	0.9296	1.025	23
640: 100% ██████████ 7/7 [00:01<00:00, 6.00it/s]	Class	Images	Instances	Box(P	R
mAP50 mAP50-95): 100% ██████████ 1/1 [00:00<00:00, 5.83it/s]					

		all	26	202	0.664	0.594
0.673	0.385					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	49/50	2.44G	1.198	0.9236	1.038	22
640:	100%	[██████████ 7/7 [00:01<00:00, 6.14it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.58it/s]				R

		all	26	202	0.703	0.574
0.679	0.386					

Size	Epoch	GPU_mem	box_loss	cls_loss	dfl_loss	Instances
	50/50	2.37G	1.164	1.104	1.142	3
640:	100%	[██████████ 7/7 [00:01<00:00, 6.09it/s]	Class	Images	Instances	Box(P
mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.92it/s]				R

		all	26	202	0.702	0.559
0.687	0.389					

50 epochs completed in 0.036 hours.

Optimizer stripped from runs/detect/train/weights/last.pt, 6.2MB

Optimizer stripped from runs/detect/train/weights/best.pt, 6.2MB

Validating runs/detect/train/weights/best.pt...

Ultralytics YOLOv8.2.61 □ Python-3.10.13 torch-2.1.2 CUDA:0 (Tesla P100-PCIE-16GB, 16269MiB)

Model summary (fused): 168 layers, 3,005,843 parameters, 0 gradients, 8.1 GFLOPs

mAP50	mAP50-95):	100% ██████████ 1/1 [00:00<00:00, 5.25it/s]	Class	Images	Instances	Box(P	R
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			all	26	202	0.626	0.688
0.71	0.412						

Speed: 0.2ms preprocess, 2.1ms inference, 0.0ms loss, 1.1ms postprocess per image

Results saved to runs/detect/train

{"model_id": "", "version_major": 2, "version_minor": 0}

```
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>
<IPython.core.display.HTML object>

ultralytics.utils.metrics.DetMetrics object with attributes:

ap_class_index: array([0])
box: ultralytics.utils.metrics.Metric object
confusion_matrix: <ultralytics.utils.metrics.ConfusionMatrix object at
0x7c6ca8509990>
curves: ['Precision-Recall(B)', 'F1-Confidence(B)', 'Precision-
Confidence(B)', 'Recall-Confidence(B)']
curves_results: [[array([
  0,      0.001001,      0.002002,
0.003003,    0.004004,      0.005005,      0.006006,      0.007007,
0.008008,    0.009009,      0.01001,      0.011011,      0.012012,
0.013013,    0.014014,      0.015015,      0.016016,      0.017017,
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	0.64295,	0.64324,	0.64352,	0.64381,
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	0.65107,	0.6512,	0.65004,	0.64889,
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0.64758,	0.64791,	0.64913,	0.64924,	
	0.64865,	0.64806,	0.64746,	0.64687,
0.64628,	0.64275,	0.64316,	0.64357,	0.64398,
0.64454,	0.6459,	0.64675,	0.64755,	0.64654,
0.64524,	0.64464,	0.64171,	0.64067,	0.63963,
0.63877,	0.63898,	0.63918,	0.63938,	
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0.58016,	0.57921,	0.57426,	0.57426,	
	0.57357,	0.57273,	0.57188,	0.57103,
0.57019,	0.56934,	0.56931,	0.56931,	0.56931,
0.56931,	0.56931,	0.56931,	0.56844,	0.56385,
0.56258,	0.56132,	0.56005,	0.55941,	0.55941,
0.55941,	0.55941,	0.55941,	0.55941,	
	0.55941,	0.55941,	0.55897,	0.55833,
0.5577,	0.55707,	0.55643,	0.5558,	0.55516,
0.55453,	0.55307,	0.55151,	0.54995,	0.54917,
0.5487,	0.54822,	0.54775,	0.54728,	0.54681,
0.54634,	0.54586,	0.54539,	0.54492,	
	0.54442,	0.54382,	0.54323,	0.54263,
0.54203,	0.54143,	0.54084,	0.54024,	0.53964,
0.5396,	0.53895,	0.53605,	0.53114,	0.52856,

0.52711,	0.52566,	0.52475,	0.52475,	0.52475,
0.52475,	0.52475,	0.52475,	0.52475,	0.52475,
	0.52475,	0.52475,	0.52475,	0.52475,
0.52475,	0.52475,	0.52475,	0.52475,	0.52459,
0.5198,	0.5198,	0.5198,	0.5198,	0.5198,
0.5198,	0.5198,	0.5198,	0.5198,	0.5198,
0.5198,	0.5198,	0.5198,	0.5198,	0.5198,
	0.5198,	0.5198,	0.5198,	0.5198,
	0.5198,	0.51865,	0.51575,	0.51431,
0.51353,	0.51275,	0.51197,	0.51119,	0.51041,
0.5099,	0.5099,	0.5099,	0.5099,	0.5099,
0.5099,	0.5099,	0.5099,	0.5099,	0.5099,
0.5099,	0.5099,	0.50495,	0.50495,	
	0.50495,	0.50495,	0.50495,	0.50495,
0.50481,	0.50436,	0.50391,	0.50346,	0.50301,
0.50256,	0.50211,	0.50166,	0.50121,	0.50075,
0.5003,	0.4994,	0.49755,	0.49571,	0.49479,
0.49438,	0.49398,	0.49357,	0.49316,	
	0.49276,	0.49235,	0.49195,	0.49154,
0.49113,	0.49073,	0.49032,	0.48962,	0.48855,
0.48748,	0.48641,	0.48535,	0.48377,	0.48208,
0.48039,	0.4802,	0.4802,	0.4802,	0.4802,
0.4802,	0.4802,	0.47943,	0.47689,	
	0.47525,	0.47525,	0.47525,	0.47525,
0.47525,	0.47525,	0.47525,	0.47525,	0.47525,
0.47525,	0.47525,	0.47517,	0.47461,	0.47405,
0.47348,	0.47292,	0.47235,	0.47179,	0.47123,
0.47066,	0.4703,	0.4703,	0.4703,	
	0.46981,	0.46909,	0.46836,	0.46764,
0.46691,	0.46619,	0.46546,	0.46449,	0.46348,
0.46246,	0.46145,	0.46043,	0.4604,	0.4604,
0.4604,	0.4604,	0.4604,	0.46025,	0.4589,
0.45754,	0.45619,	0.45316,	0.44809,	
	0.44518,	0.44446,	0.44373,	0.44301,
0.44228,	0.44156,	0.44083,	0.44022,	0.43965,
0.43909,	0.43852,	0.43796,	0.4374,	0.43683,
0.43627,	0.43571,	0.43564,	0.43564,	0.43564,
0.43564,	0.43564,	0.43564,	0.43564,	
	0.43564,	0.43564,	0.43564,	0.43564,
0.43564,	0.43564,	0.43564,	0.43564,	0.43529,
0.43402,	0.43275,	0.43148,	0.43021,	0.42895,
0.42768,	0.42641,	0.42574,	0.42574,	0.42574,
0.42574,	0.42574,	0.42574,	0.42574,	
	0.42574,	0.42574,	0.42574,	0.42574,
0.42574,	0.42184,	0.41677,	0.41584,	0.41584,
0.41584,	0.41584,	0.41584,	0.41584,	0.41584,
0.41584,	0.41581,	0.41496,	0.41412,	0.41327,
0.41243,	0.41158,	0.41089,	0.41089,	
	0.41089,	0.41089,	0.41089,	0.41089,
0.41089,	0.41089,	0.41089,	0.41089,	0.41089,
0.41089,	0.41089,	0.41089,	0.41089,	0.41089,

0.41089,	0.41089,	0.41089,	0.41089,	0.40975,
0.40806,	0.40637,	0.40594,	0.40594,	
	0.40594,	0.40594,	0.40594,	0.40594,
0.40594,	0.40594,	0.40561,	0.40489,	0.40416,
0.40344,	0.40271,	0.40199,	0.40126,	0.40067,
0.40017,	0.39966,	0.39915,	0.39864,	0.39814,
0.39763,	0.39712,	0.39661,	0.39611,	
	0.39604,	0.39604,	0.39604,	0.39604,
0.39604,	0.39604,	0.39604,	0.39604,	0.39604,
0.39604,	0.39604,	0.39604,	0.39604,	0.39604,
0.39604,	0.39604,	0.39604,	0.39572,	0.39531,
0.39491,	0.3945,	0.39409,	0.39369,	
	0.39328,	0.39288,	0.39247,	0.39206,
0.39166,	0.39125,	0.38804,	0.38614,	0.38614,
0.38568,	0.38501,	0.38433,	0.38365,	0.38298,
0.3823,	0.38162,	0.381,	0.38046,	0.37993,
0.3794,	0.37886,	0.37833,	0.37779,	
	0.37726,	0.37672,	0.3762,	0.37574,
0.37527,	0.37481,	0.37435,	0.37389,	0.37343,
0.37297,	0.37251,	0.37205,	0.37158,	0.37129,
0.37073,	0.36928,	0.36783,	0.36638,	0.36634,
0.36135,	0.35881,	0.35644,	0.35644,	
	0.35644,	0.35644,	0.35644,	0.35644,
0.35644,	0.35644,	0.35644,	0.35644,	0.35644,
0.35644,	0.35644,	0.35644,	0.35644,	0.35644,
0.35509,	0.35455,	0.35402,	0.35348,	
	0.35295,	0.35241,	0.35188,	0.34587,
0.34334,	0.34127,	0.34026,	0.33924,	0.33823,
0.33721,	0.33554,	0.333,	0.33099,	0.32954,
0.32809,	0.32673,	0.32673,	0.32673,	0.32673,
0.32673,	0.32673,	0.32673,	0.32673,	
	0.32673,	0.32673,	0.32673,	0.32673,
0.32673,	0.32673,	0.32673,	0.32673,	0.32673,
0.32673,	0.32502,	0.32178,	0.32178,	0.32167,
0.32147,	0.32128,	0.32108,	0.32089,	0.32069,
0.3205,	0.3203,	0.32011,	0.31991,	
	0.31972,	0.31952,	0.31933,	0.31913,
0.31894,	0.31874,	0.31855,	0.31835,	0.31816,
0.31796,	0.31777,	0.31757,	0.31738,	0.31718,
0.31699,	0.31667,	0.31588,	0.3151,	0.31432,
0.31354,	0.31276,	0.31198,	0.31188,	
	0.31188,	0.31188,	0.31188,	0.31188,
0.31188,	0.31188,	0.31188,	0.31188,	0.30678,
0.30552,	0.30425,	0.30298,	0.30144,	0.2989,
0.29703,	0.29703,	0.29703,	0.29703,	0.29703,
0.29703,	0.29703,	0.29391,	0.29208,	
	0.29208,	0.29208,	0.29208,	0.29208,
0.29208,	0.29208,	0.29208,	0.29208,	0.29208,

0.29208,	0.29208,	0.29208,	0.29174,	0.2913,
0.29085,	0.29041,	0.28997,	0.28953,	0.28909,
0.28865,	0.28821,	0.28777,	0.28732,	
	0.28669,	0.28591,	0.28513,	0.28435,
0.28357,	0.28279,	0.28145,	0.27807,	0.27678,
0.27618,	0.27559,	0.27499,	0.27439,	0.27379,
0.2732,	0.2726,	0.27111,	0.26858,	0.26659,
0.26514,	0.26369,	0.25737,	0.25681,	
	0.25625,	0.25568,	0.25512,	0.25455,
0.25399,	0.25343,	0.25286,	0.25142,	0.24804,
0.24609,	0.2444,	0.24271,	0.23945,	0.23762,
0.23762,	0.23762,	0.23762,	0.23762,	0.23762,
0.23762,	0.23635,	0.23432,	0.23235,	
	0.23066,	0.22897,	0.22638,	0.22245,
0.22132,	0.22019,	0.21906,	0.21794,	0.21699,
0.21607,	0.21515,	0.21423,	0.2133,	0.20786,
0.20641,	0.20496,	0.20351,	0.20084,	0.19745,
0.19407,	0.19205,	0.1906,	0.18915,	
	0.18243,	0.1799,	0.17479,	0.1726,
0.17182,	0.17104,	0.17026,	0.16948,	0.1687,
0.15837,	0.15634,	0.15431,	0.15199,	0.14945,
0.1478,	0.14668,	0.14555,	0.14442,	0.14234,
0.13772,	0.13433,	0.12344,	0.12243,	
	0.12141,	0.1204,	0.11938,	0.1166,
0.11308,	0.11139,	0.1097,	0.1062,	0.10325,
0.10198,	0.10072,	0.099447,	0.098178,	0.096909,
0.095641,	0.094372,	0.091511,	0.083177,	0.079794,
0.077111,	0.074573,	0.073147,	0.071878,	
	0.07061,	0.069341,	0.066015,	0.06371,
0.062441,	0.061173,	0.059904,	0.053848,	0.049018,
0.045635,	0.042827,	0.04029,	0.039075,	0.03835,
0.037625,	0.0369,	0.036175,	0.035451,	0.034726,
0.03313,	0.031439,	0.029748,	0.024303,	
	0.023842,	0.023381,	0.022919,	0.022458,
0.021997,	0.021535,	0.021074,	0.020613,	0.020152,
0.019451,	0.018001,	0.016551,	0.015101,	0.014409,
0.013875,	0.013341,	0.012807,	0.012273,	0.011739,
0.011205,	0.01067,	0.010136,	0.0097475,	
	0.0094732,	0.0091989,	0.0089246,	0.0086503,
0.0083761,	0.0081018,	0.0078275,	0.0075532,	0.0072789,
0.0070046,	0.0067303,	0.006456,	0.0061817,	0.0059074,
0.0056331,	0.0053589,	0.0050846,	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: 0.44156191107758164  

keys: ['metrics/precision(B)', 'metrics/recall(B)',  

'metrics/mAP50(B)', 'metrics/mAP50-95(B)']  

maps: array([ 0.41176])  

names: {0: 'class_0'}  

plot: True  

results_dict: {'metrics/precision(B)': 0.6255036717369269,  

'metrics/recall(B)': 0.6881188118811881, 'metrics/mAP50(B)':  

0.7098057077489301, 'metrics/mAP50-95(B)': 0.41175704478076514,  

'fitness': 0.44156191107758164}  

save_dir: PosixPath('runs/detect/train')  

speed: {'preprocess': 0.16740652231069714, 'inference':  

2.0882716545691857, 'loss': 0.0004493273221529447, 'postprocess':  

1.0575239474956806}  

task: 'detect'

# Evaluate the model  

results = model.val()

# Save the trained model  

model.save('/kaggle/working/model.pt')

Ultralytics YOLOv8.2.61 □ Python-3.10.13 torch-2.1.2 CUDA:0 (Tesla  

P100-PCIE-16GB, 16269MiB)  

Model summary (fused): 168 layers, 3,005,843 parameters, 0 gradients,  

8.1 GFLOPs

val: Scanning /kaggle/input/martian-lunar-craters-dataset/MARTIAN-  

LUNAR/craters/valid/labels... 26 images, 2 backgrounds, 0 corrupt:  

100%|██████████| 26/26 [00:00<00:00, 858.31it/s]

val: WARNING △ Cache directory /kaggle/input/martian-lunar-craters-  

dataset/MARTIAN-LUNAR/craters/valid is not writeable, cache not saved.

/opt/conda/lib/python3.10/multiprocessing/popen_fork.py:66:  

RuntimeWarning:

os.fork() was called. os.fork() is incompatible with multithreaded  

code, and JAX is multithreaded, so this will likely lead to a  

deadlock.

          Class    Images Instances      Box(P      R
mAP50  mAP50-95): 100%|██████████| 2/2 [00:00<00:00,  2.63it/s]  

          all        26       202      0.627      0.688  

0.71      0.413  

Speed: 0.2ms preprocess, 14.6ms inference, 0.0ms loss, 2.2ms

```

```

postprocess per image
Results saved to runs/detect/train2

# Visualize sample detections
def visualize_detections(model, image_path, n_samples=10):
    image_files = os.listdir(image_path)[:n_samples]
    for img_file in image_files:
        img_path = os.path.join(image_path, img_file)
        img = cv2.imread(img_path)
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        results = model(img_path)

        fig, ax = plt.subplots(1, 1, figsize=(10, 10))
        ax.imshow(img)

        for result in results[0].boxes:
            x_min, y_min, x_max, y_max = result.xyxy[0].tolist()
            conf = result.conf[0].item()
            rect = plt.Rectangle((x_min, y_min), x_max - x_min, y_max
- y_min, edgecolor='red', facecolor='none', linewidth=2)
            ax.add_patch(rect)
            ax.text(x_min, y_min, f'{conf:.2f}', bbox=dict(facecolor='yellow', alpha=0.5))

        plt.title(f'Detection in: {img_file}')
        plt.axis('off')
        plt.show()

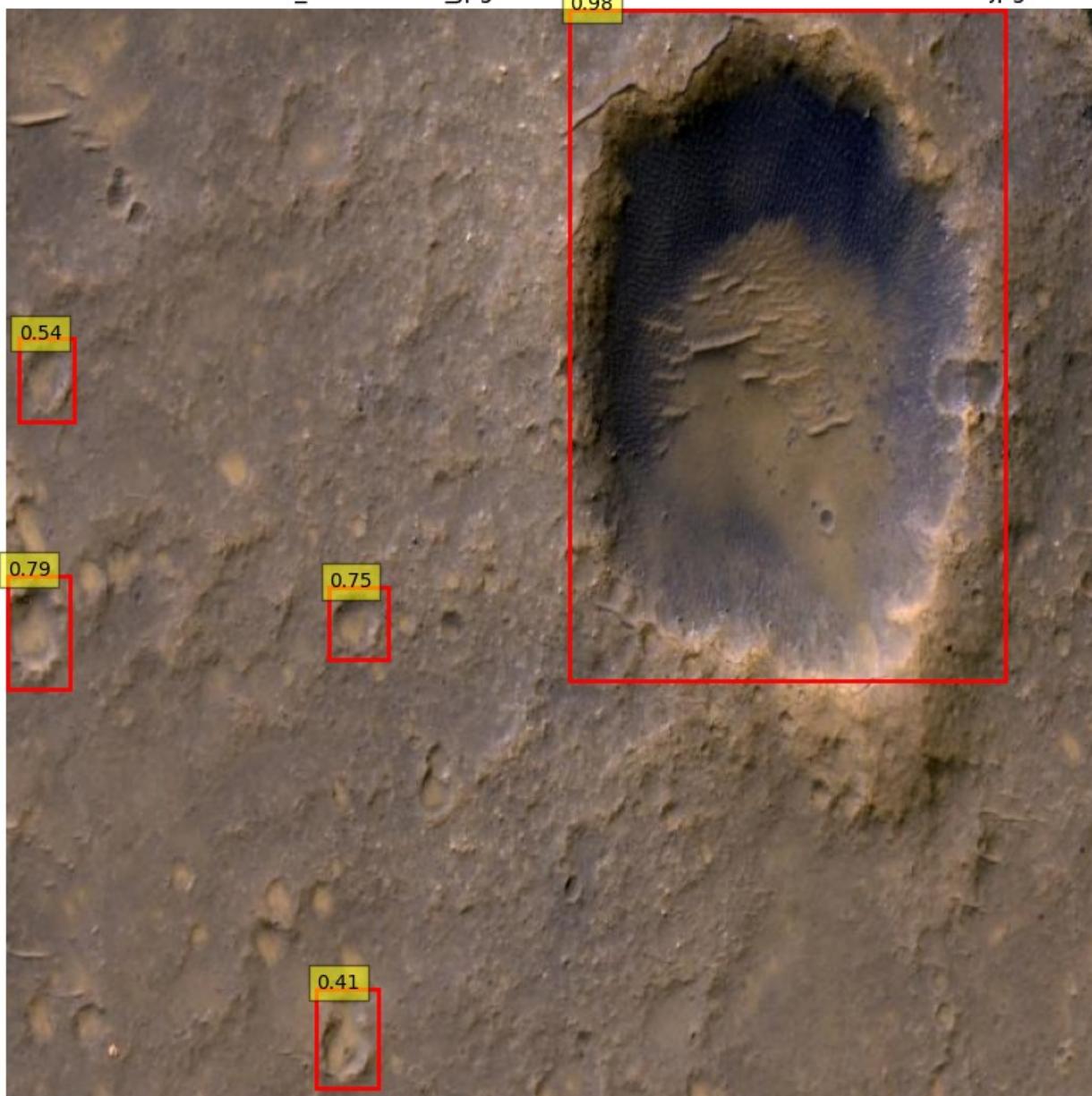
visualize_detections(model, test_img_path)

print("Model training, evaluation, and sample visualization completed.
The trained model is saved at '/kaggle/working/best_model.pt'.")

```

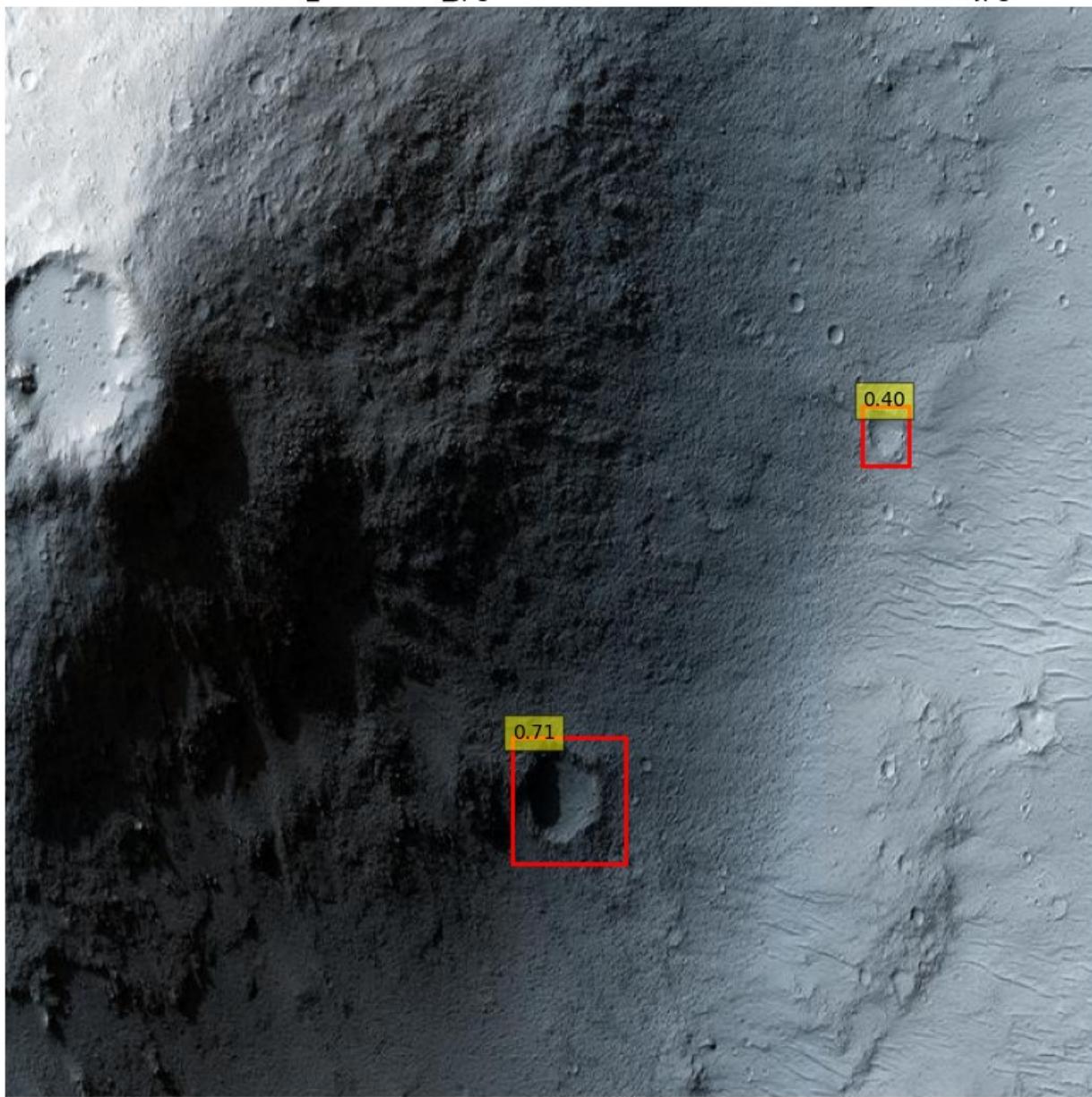
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--100-
_jpg.rf.a2ad5867efb2d73e86d9d980ca40a9fe.jpg: 640x640 5 class_0s,
6.0ms
Speed: 2.1ms preprocess, 6.0ms inference, 1.5ms postprocess per image
at shape (1, 3, 640, 640)

Detection in: mars_crater--100-.jpg.rf.a2ad5867efb2d73e86d9d980ca40a9fe.jpg



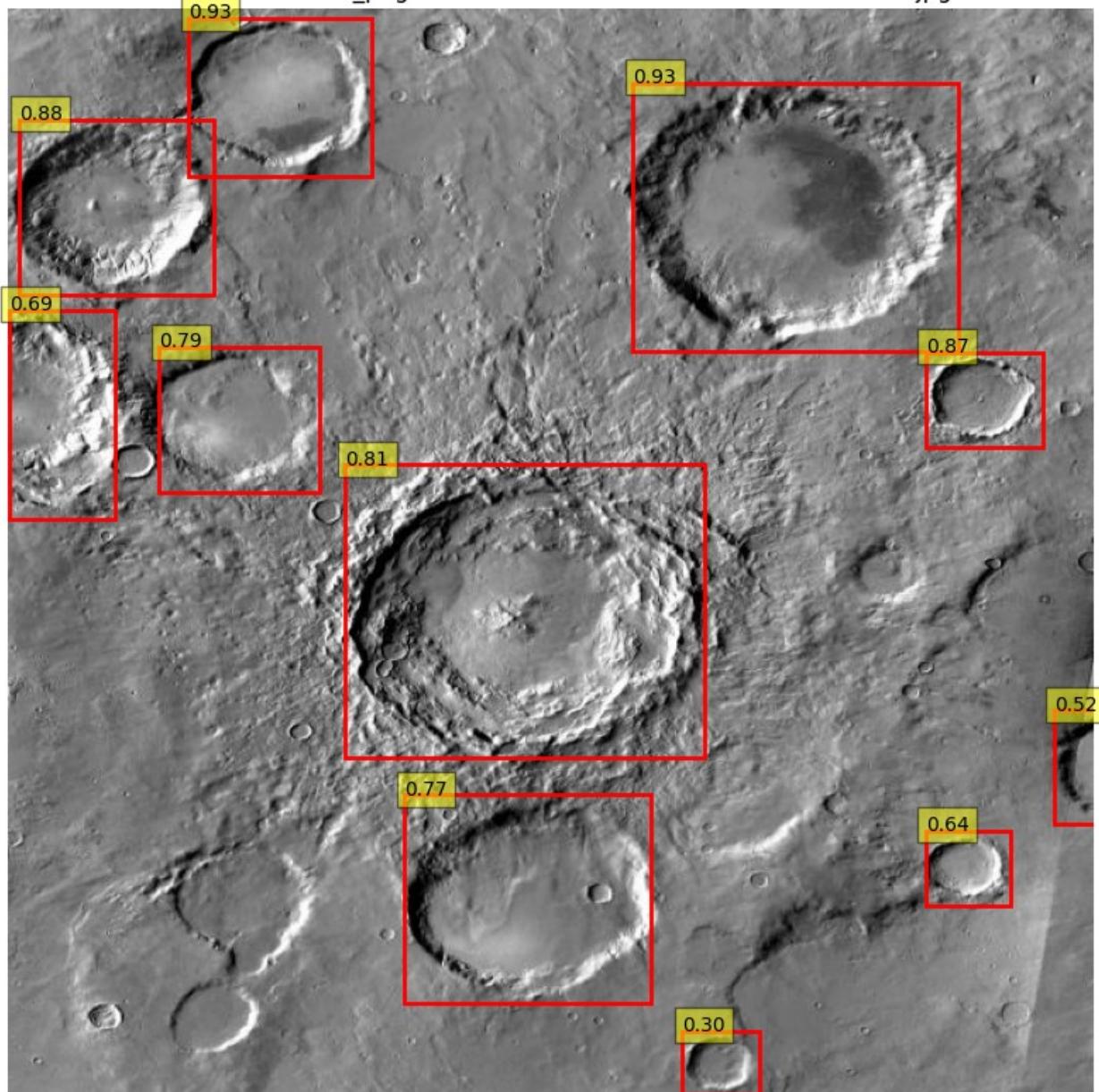
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--51-
.jpg.rf.2f21cd1782f9da8bb8f1ada8efa134a7.jpg: 640x640 2 class_0s,
6.8ms
Speed: 1.6ms preprocess, 6.8ms inference, 1.8ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--51_.jpg.rf.2f21cd1782f9da8bb8f1ada8efa134a7.jpg



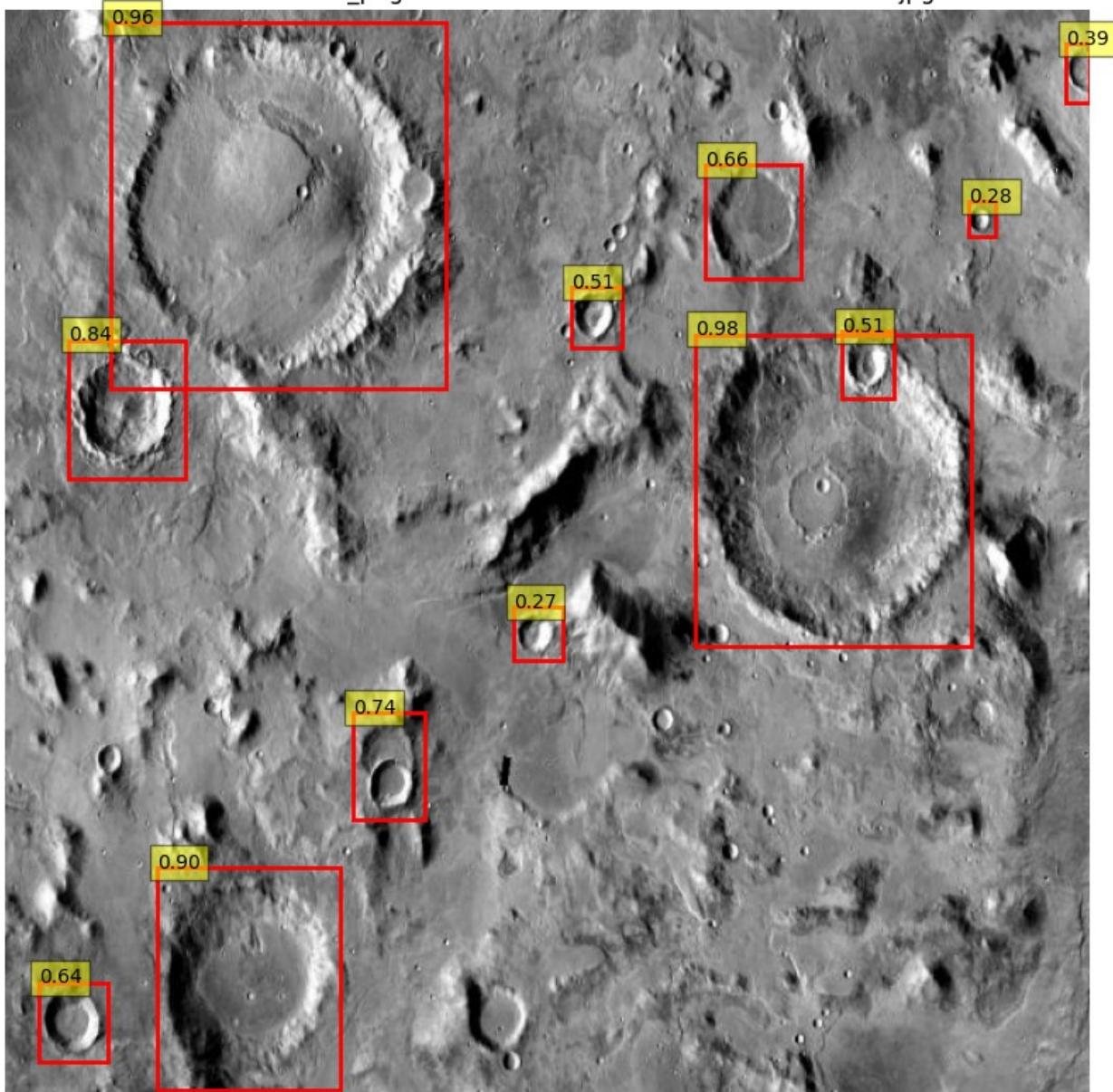
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/015_.png.rf.7d5b2091b6339c9480a171a59c52c3b9.jpg: 640x640
11 class_0s, 6.9ms
Speed: 1.5ms preprocess, 6.9ms inference, 1.4ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: 015_png.rf.7d5b2091b6339c9480a171a59c52c3b9.jpg



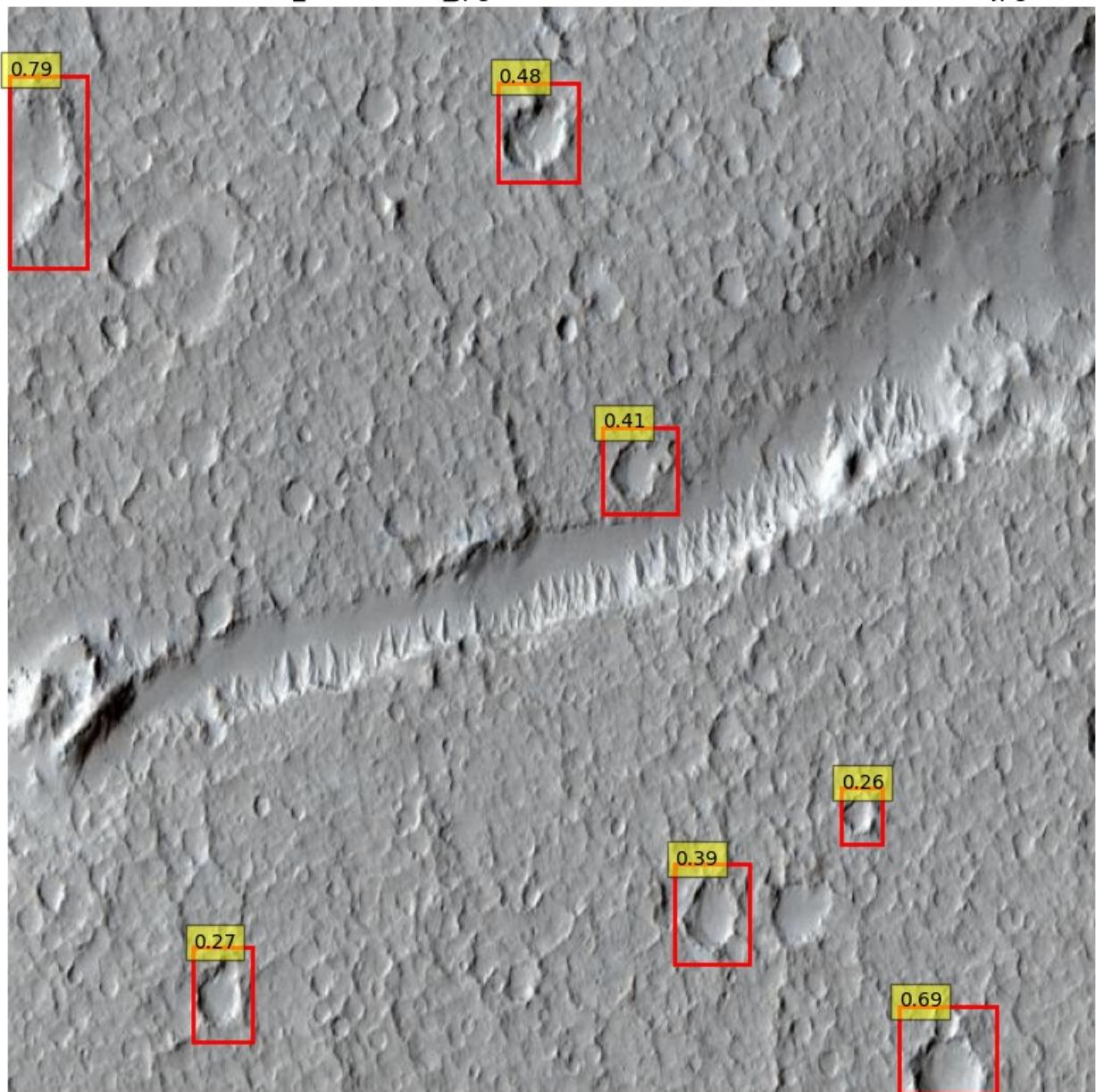
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/04_png.rf.81a7d6cbeb9dc09e5a8ecd40e185fc92.jpg: 640x640 12
class_0s, 6.7ms
Speed: 1.5ms preprocess, 6.7ms inference, 1.4ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: 04.png.rf.81a7d6cbeb9dc09e5a8ecd40e185fc92.jpg



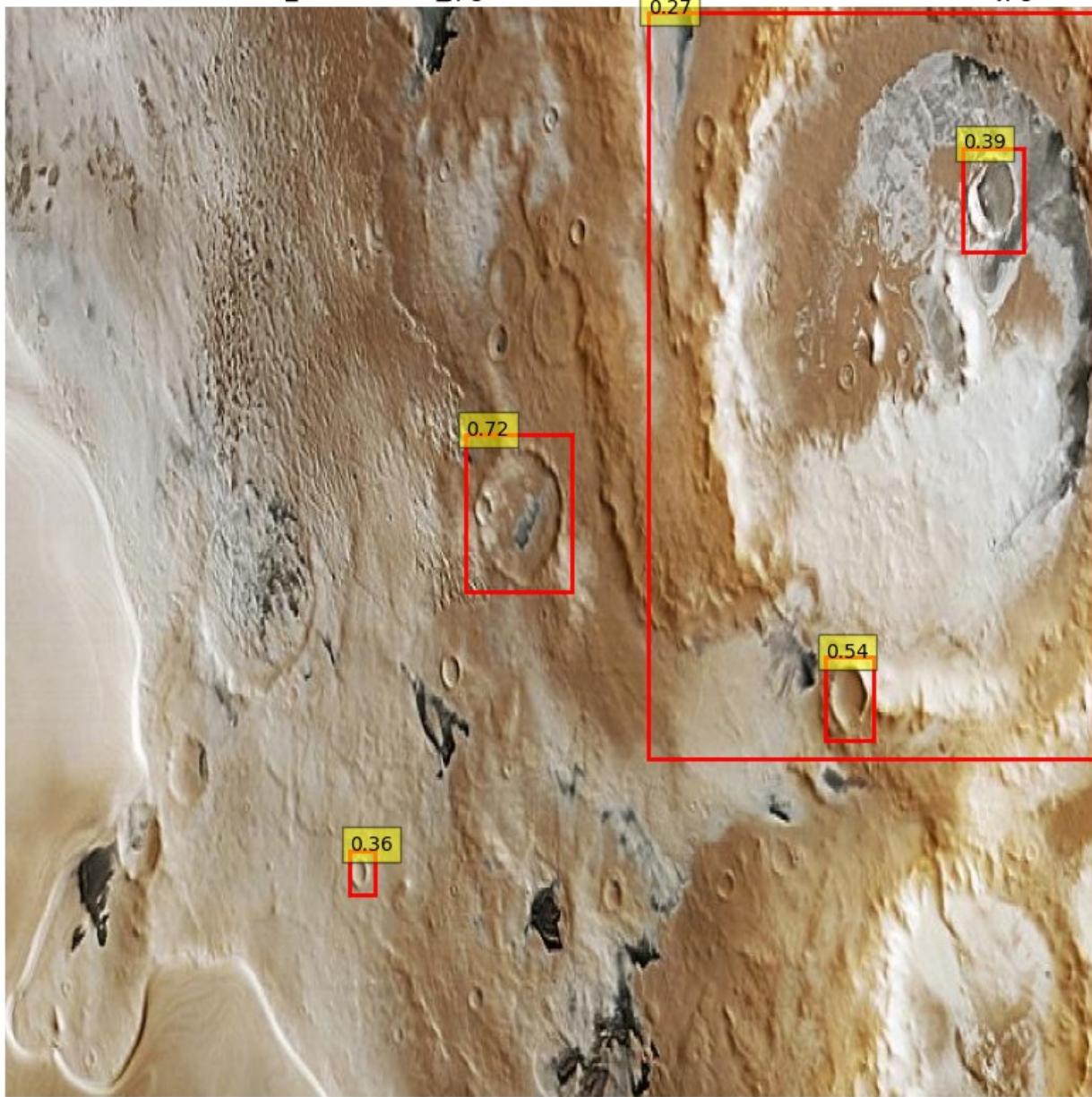
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--117-
.jpg.rf.b412b6593d102c5f9dda7bce79bb815c.jpg: 640x640 7 class_0s,
6.8ms
Speed: 1.6ms preprocess, 6.8ms inference, 1.3ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--117_.jpg.rf.b412b6593d102c5f9dda7bce79bb815c.jpg



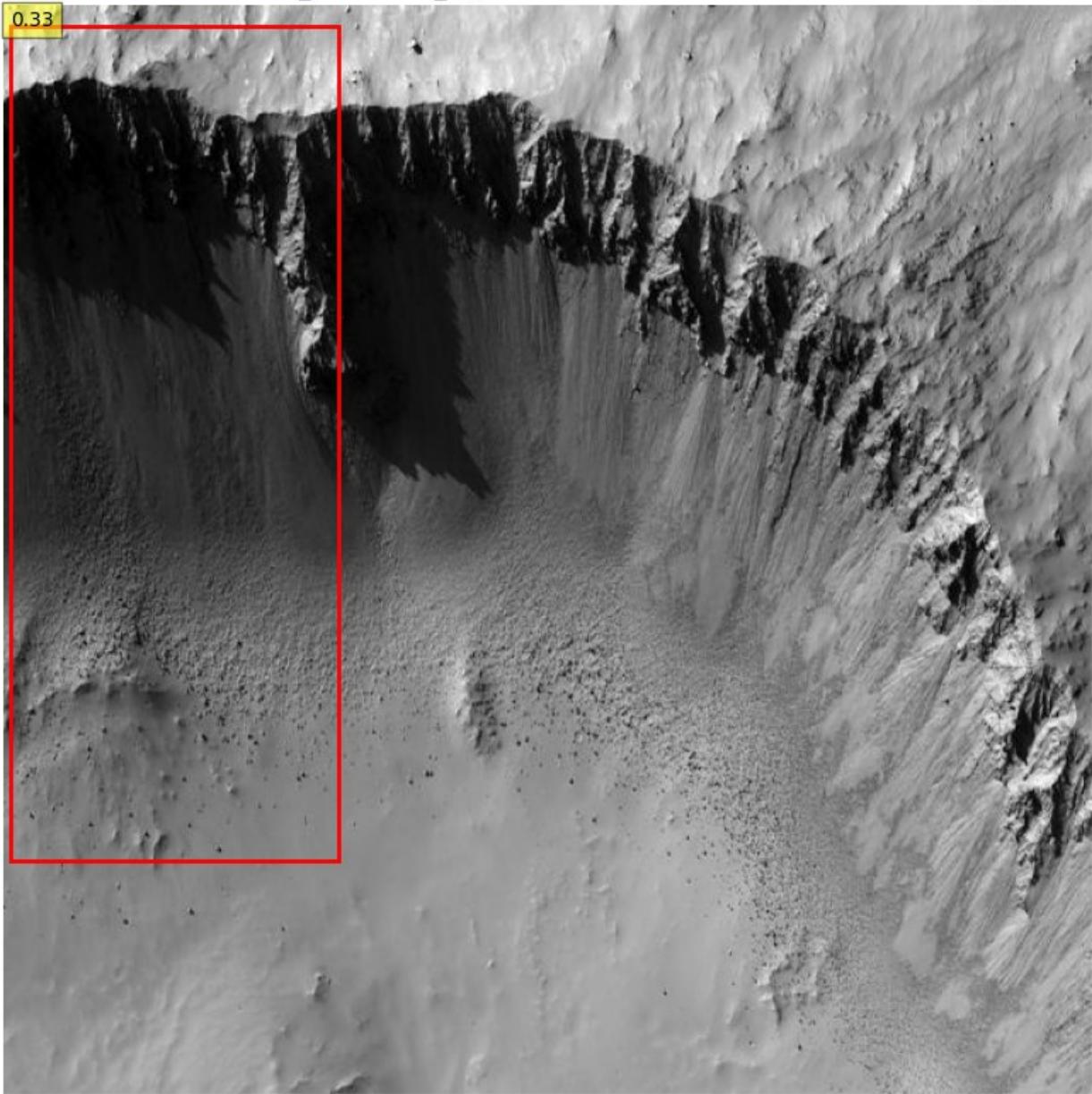
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--116-
.jpg.rf.2e550a693a8800808e68848484716b95.jpg: 640x640 5 class_0s,
7.7ms
Speed: 1.6ms preprocess, 7.7ms inference, 1.4ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--116-.jpg.rf.2e550a693a8800808e68848484716b95.jpg



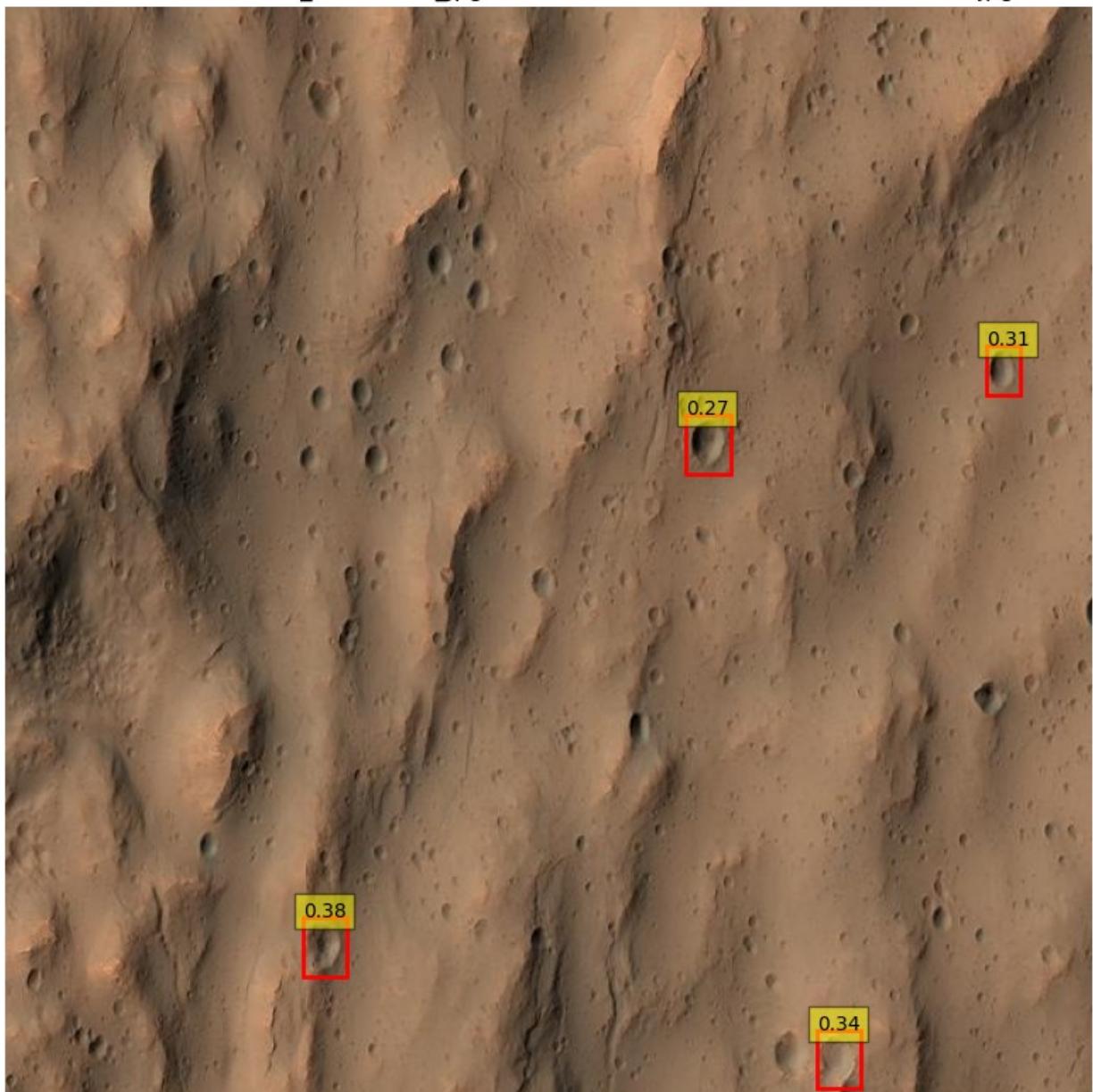
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--33-
.jpg.rf.baf9c7be01ba1f4b954e0e5be0560c80.jpg: 640x640 1 class_0, 7.0ms
Speed: 1.8ms preprocess, 7.0ms inference, 1.5ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--33-.jpg.rf.baf9c7be01ba1f4b954e0e5be0560c80.jpg



```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--65-
.jpg.rf.34ab64f1f6ce5a4b360ea66eae77d4b9.jpg: 640x640 4 class_0s,
6.9ms
Speed: 1.6ms preprocess, 6.9ms inference, 1.3ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--65-.jpg.rf.34ab64f1f6ce5a4b360ea66eae77d4b9.jpg



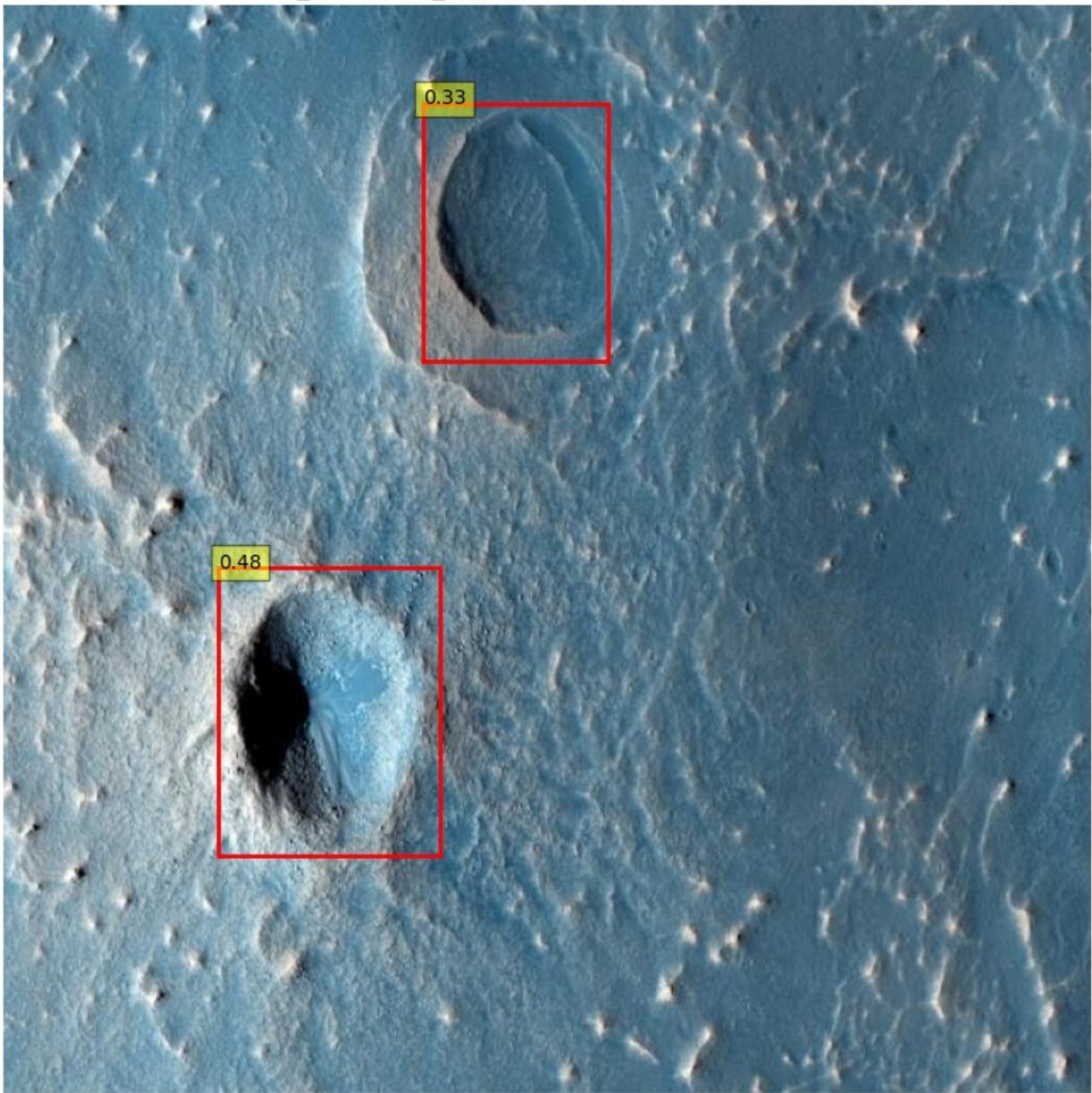
```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--46-
.jpg.rf.369e88a43859f97a595d2091746600f4.jpg: 640x640 1 class_0, 7.0ms
Speed: 1.6ms preprocess, 7.0ms inference, 1.4ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--46-.jpg.rf.369e88a43859f97a595d2091746600f4.jpg



```
image 1/1
/kaggle/input/martian-lunar-craters-dataset/MARTIAN-LUNAR/craters/
test/images/mars_crater--25-
.jpg.rf.a06bfa24b404b064ead471f56d636e0e.jpg: 640x640 2 class_0s,
6.6ms
Speed: 1.5ms preprocess, 6.6ms inference, 1.3ms postprocess per image
at shape (1, 3, 640, 640)
```

Detection in: mars_crater--25-.jpg.rf.a06bfa24b404b064ead471f56d636e0e.jpg



Model training, evaluation, and sample visualization completed. The trained model is saved at '/kaggle/working/best_model.pt'.

```
import os
import cv2
import matplotlib.pyplot as plt

def visualize_detections(model, folder_path, n_samples=10):
    # Check if the folder path exists
    if not os.path.exists(folder_path):
        print(f"Error: The folder path {folder_path} does not exist.")
```

```

    return

    # Get list of image files in the folder
    image_files = [f for f in os.listdir(folder_path) if
os.path.isfile(os.path.join(folder_path, f))]
    if not image_files:
        print(f"Error: No image files found in folder {folder_path}.")
        return

    # Process up to n_samples images
    image_files = image_files[:n_samples]

    for img_file in image_files:
        img_path = os.path.join(folder_path, img_file)

        # Try to read the image
        img = cv2.imread(img_path)
        if img is None:
            print(f"Error: Failed to load image at {img_path}.")
Skipping this file."
            continue

        # Convert the image to RGB
        try:
            img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        except cv2.error as e:
            print(f"Error during color conversion for image
{img_path}: {e}")
            continue

        # Perform model inference
        try:
            results = model(img_path)
        except Exception as e:
            print(f"Error during model inference for image {img_path}:
{e}")
            continue

        # Visualize the results
        fig, ax = plt.subplots(1, 1, figsize=(10, 10))
        ax.imshow(img)

        for result in results[0].boxes:
            x_min, y_min, x_max, y_max = result.xyxy[0].tolist()
            conf = result.conf[0].item()
            rect = plt.Rectangle((x_min, y_min), x_max - x_min, y_max
- y_min, edgecolor='red', facecolor='none', linewidth=2)
            ax.add_patch(rect)
            ax.text(x_min, y_min, f'{conf:.2f}',


```

```
        bbox=dict(facecolor='yellow', alpha=0.5))

    plt.title(f'Detection in: {os.path.basename(img_path)}')
    plt.axis('off')
    plt.show()

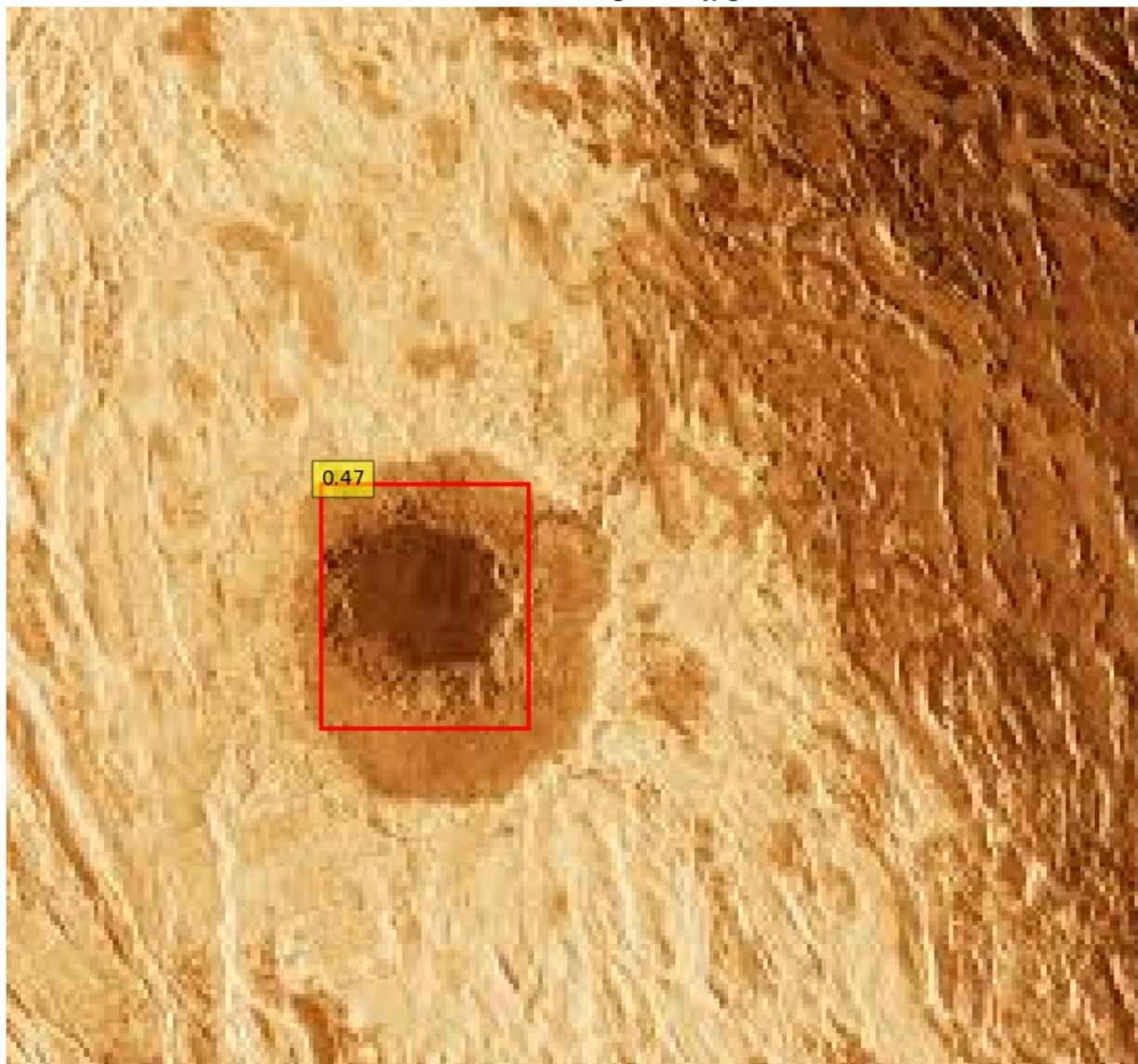
# Example usage:
# Input folder path from user
folder_path = input("Enter the path of the folder containing images:
")
visualize_detections(model, folder_path)

print("Model training, evaluation, and sample visualization completed.
The trained model is saved at '/kaggle/working/best_model.pt'.")
```

Enter the path of the folder containing images: /kaggle/input/venus-craters/venus_crater_user_test

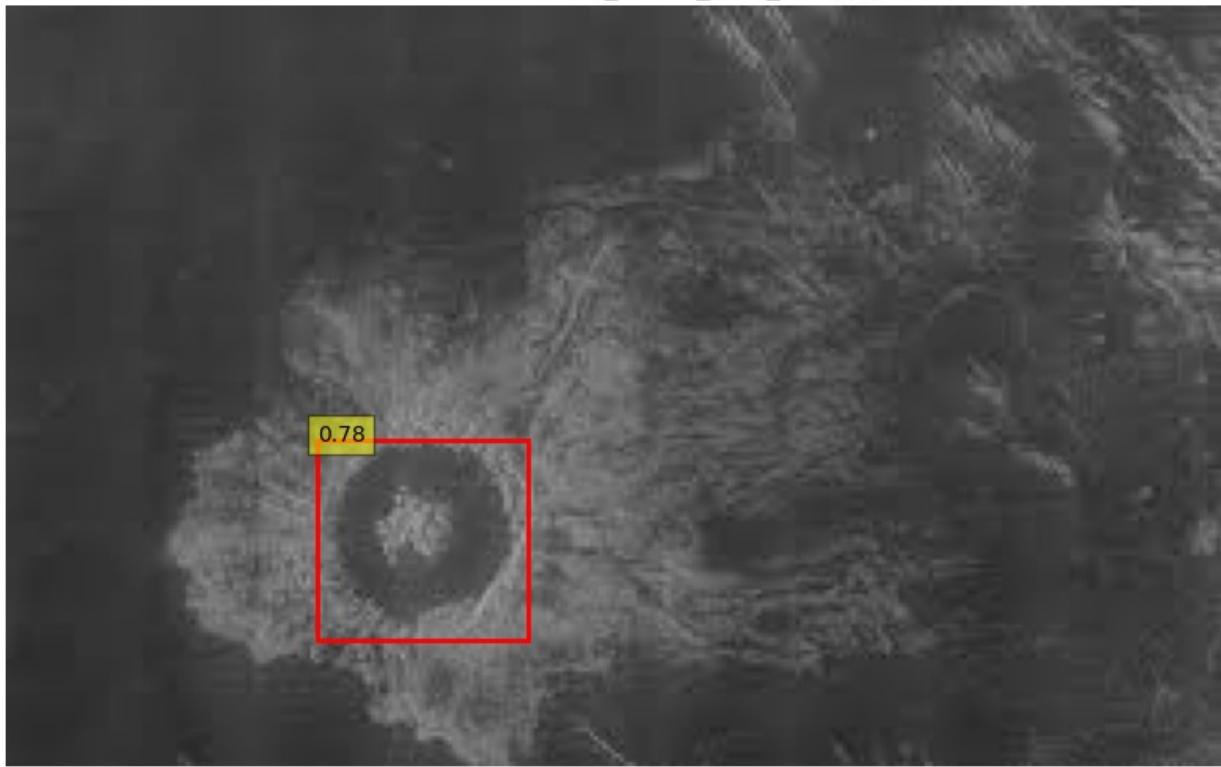
```
image 1/1 /kaggle/input/venus-craters/venus_crater_user_test/images
(2).jpg: 608x640 1 class_0, 57.9ms
Speed: 2.8ms preprocess, 57.9ms inference, 1.7ms postprocess per image
at shape (1, 3, 608, 640)
```

Detection in: images (2).jpg



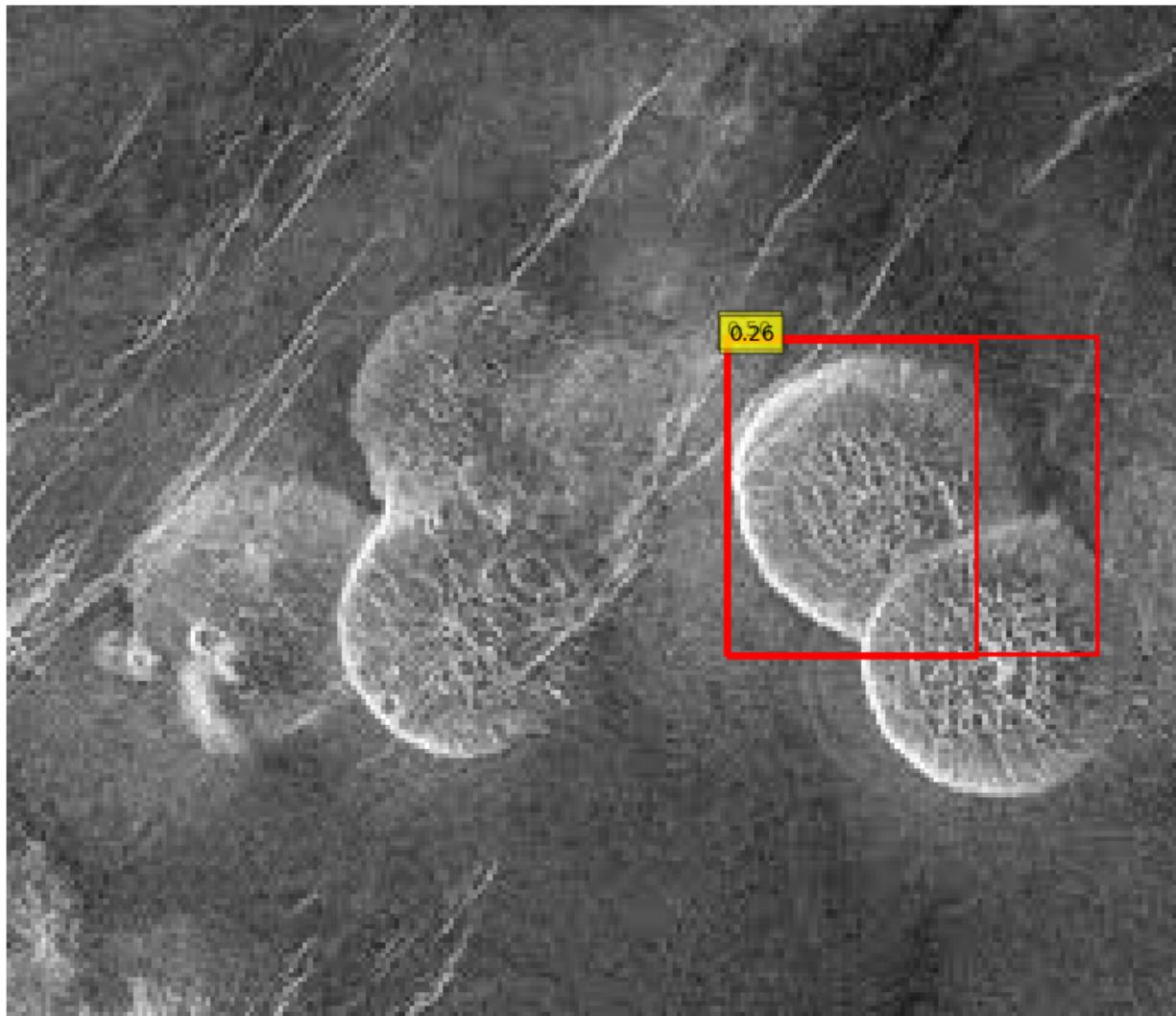
```
image 1/1
/kaggle/input/venus-craters/venus_crater_user_test/venus_crater_user_t
est.jpg: 416x640 1 class_0, 7.4ms
Speed: 1.7ms preprocess, 7.4ms inference, 1.3ms postprocess per image
at shape (1, 3, 416, 640)
```

Detection in: venus_crater_user_test.jpg



```
image 1/1 /kaggle/input/venus-craters/venus_crater_user_test/images  
(1).jpg: 576x640 2 class_0s, 55.7ms  
Speed: 2.2ms preprocess, 55.7ms inference, 1.3ms postprocess per image  
at shape (1, 3, 576, 640)
```

Detection in: images (1).jpg



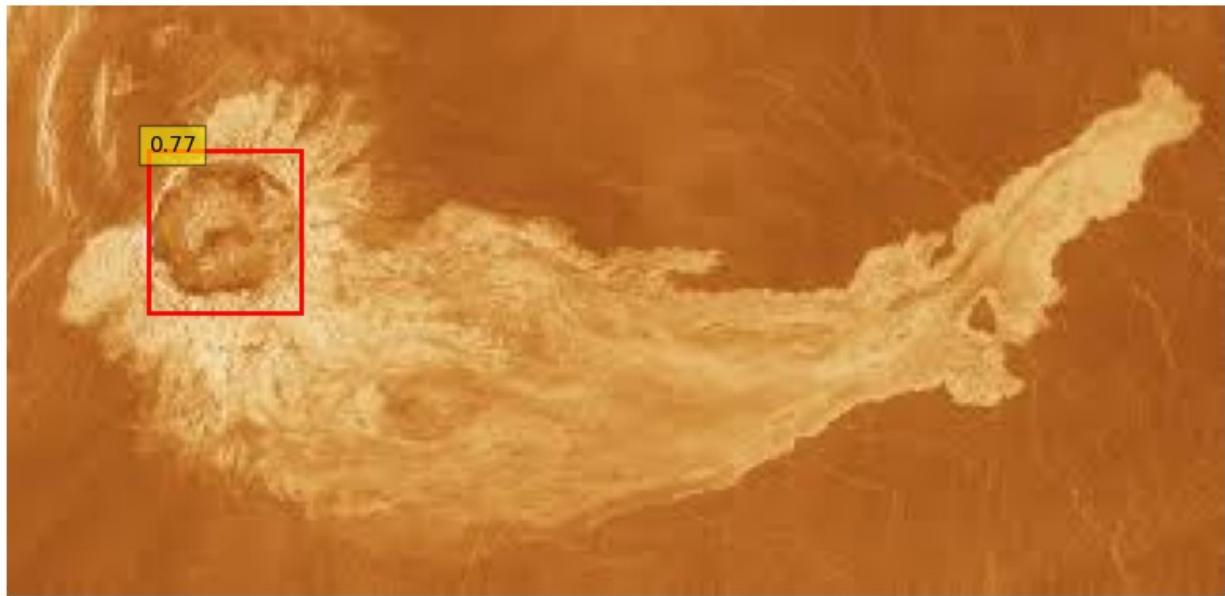
```
image 1/1 /kaggle/input/venus-craters/venus_crater_user_test/download  
(1).jpg: 640x544 1 class_0, 54.5ms  
Speed: 2.0ms preprocess, 54.5ms inference, 1.4ms postprocess per image  
at shape (1, 3, 640, 544)
```

Detection in: download (1).jpg



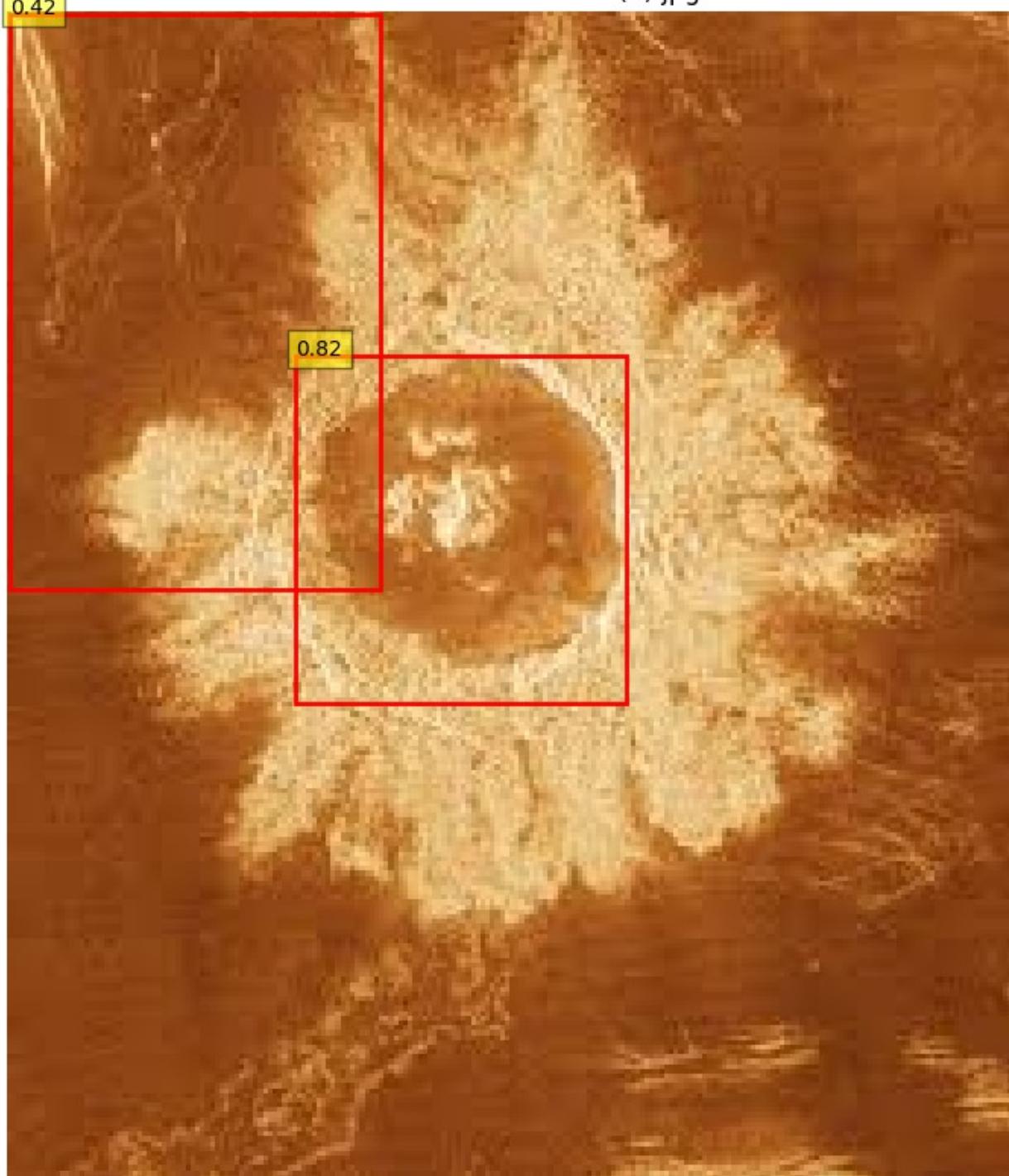
```
image 1/1 /kaggle/input/venus-craters/venus_crater_user_test/images  
(3).jpg: 320x640 1 class_0, 55.4ms  
Speed: 1.4ms preprocess, 55.4ms inference, 1.3ms postprocess per image  
at shape (1, 3, 320, 640)
```

Detection in: images (3).jpg



```
image 1/1 /kaggle/input/venus-craters/venus_crater_user_test/download  
(2).jpg: 640x576 2 class_0s, 54.4ms  
Speed: 2.1ms preprocess, 54.4ms inference, 1.3ms postprocess per image  
at shape (1, 3, 640, 576)
```

Detection in: download (2).jpg



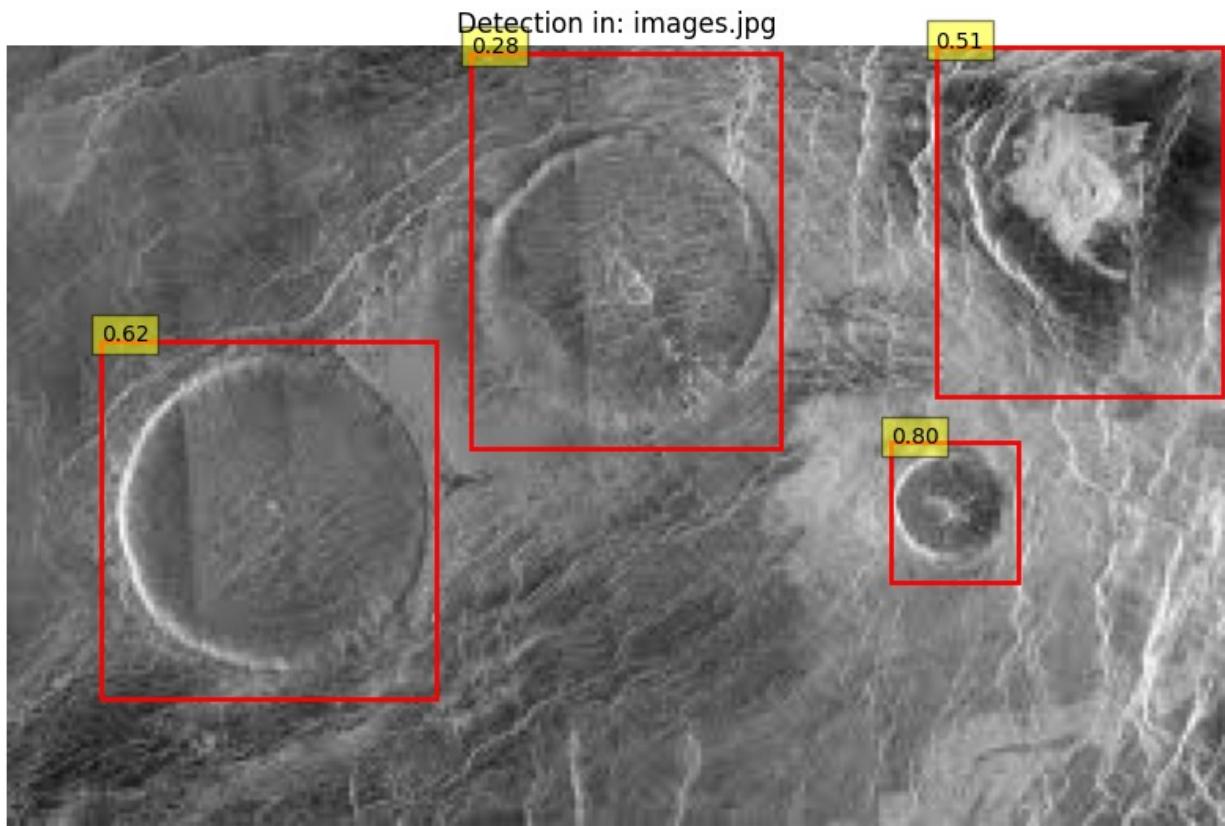
```
image 1/1  
/kaggle/input/venus-craters/venus_crater_user_test/download.jpg:  
320x640 1 class_0, 7.8ms
```

```
Speed: 1.7ms preprocess, 7.8ms inference, 1.3ms postprocess per image  
at shape (1, 3, 320, 640)
```

Detection in: download.jpg



```
image 1/1  
/kaggle/input/venus-craters/venus_crater_user_test/images.jpg: 416x640  
4 class_0s, 7.6ms  
Speed: 1.7ms preprocess, 7.6ms inference, 1.3ms postprocess per image  
at shape (1, 3, 416, 640)
```



Model training, evaluation, and sample visualization completed. The trained model is saved at '/kaggle/working/best_model.pt'.