

Lab-1

Task 1

```
!pip install diffusers transformers accelerate torch
```

```
Requirement already satisfied: diffusers in /usr/local/lib/python3.12/dist-packages (0.36.0)
Requirement already satisfied: transformers in /usr/local/lib/python3.12/dist-packages (4.57.3)
Requirement already satisfied: accelerate in /usr/local/lib/python3.12/dist-packages (1.12.0)
Requirement already satisfied: torch in /usr/local/lib/python3.12/dist-packages (2.9.0+cu126)
Requirement already satisfied: importlib_metadata in /usr/local/lib/python3.12/dist-packages (from diffusers) (8.7.1)
Requirement already satisfied: filelock in /usr/local/lib/python3.12/dist-packages (from diffusers) (3.20.2)
Requirement already satisfied: httpx<1.0.0 in /usr/local/lib/python3.12/dist-packages (from diffusers) (0.28.1)
Requirement already satisfied: huggingface-hub<2.0,>=0.34.0 in /usr/local/lib/python3.12/dist-packages (from diffusers) (0.36.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.12/dist-packages (from diffusers) (2.0.2)
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.12/dist-packages (from diffusers) (2025.11.3)
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Requirement already satisfied: safetensors>=0.3.1 in /usr/local/lib/python3.12/dist-packages (from diffusers) (0.7.0)
Requirement already satisfied: Pillow in /usr/local/lib/python3.12/dist-packages (from diffusers) (11.3.0)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (25.0)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.12/dist-packages (from transformers) (6.0.3)
Requirement already satisfied: tokenizers<=0.23.0,>=0.22.0 in /usr/local/lib/python3.12/dist-packages (from transformers) (0.22.2)
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.12/dist-packages (from transformers) (4.67.1)
Requirement already satisfied: psutil in /usr/local/lib/python3.12/dist-packages (from accelerate) (5.9.5)
Requirement already satisfied: typing-extensions>=4.10.0 in /usr/local/lib/python3.12/dist-packages (from torch) (4.15.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages (from torch) (75.2.0)
Requirement already satisfied: sympy>=1.13.3 in /usr/local/lib/python3.12/dist-packages (from torch) (1.14.0)
Requirement already satisfied: networkx>=2.5.1 in /usr/local/lib/python3.12/dist-packages (from torch) (3.6.1)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (from torch) (3.1.6)
Requirement already satisfied: fsspec>=0.8.5 in /usr/local/lib/python3.12/dist-packages (from torch) (2025.3.0)
Requirement already satisfied: nvidia-cuda-nvrtc-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
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Requirement already satisfied: nvidia-nvJITLink-cu12==12.6.85 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.85)
Requirement already satisfied: nvidia-cufile-cu12==1.11.1.6 in /usr/local/lib/python3.12/dist-packages (from torch) (1.11.1.6)
Requirement already satisfied: triton==3.5.0 in /usr/local/lib/python3.12/dist-packages (from torch) (3.5.0)
Requirement already satisfied: anyio in /usr/local/lib/python3.12/dist-packages (from httpx<1.0.0->diffusers) (4.12.1)
Requirement already satisfied: certifi in /usr/local/lib/python3.12/dist-packages (from httpx<1.0.0->diffusers) (2026.1.4)
Requirement already satisfied: httpcore==1.* in /usr/local/lib/python3.12/dist-packages (from httpx<1.0.0->diffusers) (1.0.9)
Requirement already satisfied: idna in /usr/local/lib/python3.12/dist-packages (from httpx<1.0.0->diffusers) (3.11)
Requirement already satisfied: h11>=0.16 in /usr/local/lib/python3.12/dist-packages (from httpcore==1.*->httpx<1.0.0->diffusers) (0.16.0)
Requirement already satisfied: hf-xet<2.0.0,>=1.1.3 in /usr/local/lib/python3.12/dist-packages (from huggingface-hub<2.0,>=0.34.0->diffusers) (1.2.0)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in /usr/local/lib/python3.12/dist-packages (from sympy>=1.13.3->torch) (1.3.0)
Requirement already satisfied: zipp>=3.20 in /usr/local/lib/python3.12/dist-packages (from importlib_metadata->diffusers) (3.23.0)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from jinja2->torch) (3.0.3)
Requirement already satisfied: charset_normalizer<4,>=2 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (3.4.4)
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (2.5.0)
```

```
from diffusers import StableDiffusionPipeline
import torch
import os
```

```
model_id = "runwayml/stable-diffusion-v1-5"
```

```
pipe = StableDiffusionPipeline.from_pretrained(
    model_id,
    torch_dtype=torch.float16
)
pipe = pipe.to("cuda")
```

Flax classes are deprecated and will be removed in Diffusers v1.0.0. We recommend migrating to PyTorch classes or pinning your version of Diffusers.
Flax classes are deprecated and will be removed in Diffusers v1.0.0. We recommend migrating to PyTorch classes or pinning your version of Diffusers.
/usr/local/lib/python3.12/dist-packages/huggingface_hub/utils/_auth.py:94: UserWarning:

The secret `HF_TOKEN` does not exist in your Colab secrets.

To authenticate with the Hugging Face Hub, create a token in your settings tab (<https://huggingface.co/settings/tokens>), set it as secret in your Google Colab and restart your session.

You will be able to reuse this secret in all of your notebooks.

Please note that authentication is recommended but still optional to access public models or datasets.

```
    warnings.warn(
```

model_index.json: 100%

541/541 [00:00<00:00, 62.8kB/s]

Fetching 15 files: 100%

15/15 [00:36<00:00, 2.36s/it]

preprocessor_config.json: 100%

342/342 [00:00<00:00, 35.2kB/s]

tokenizer_config.json: 100%

806/806 [00:00<00:00, 107kB/s]

vocab.json: 1.06M/? [00:00<00:00, 8.75MB/s]

config.json: 100%

617/617 [00:00<00:00, 8.53kB/s]

merges.txt: 525k/? [00:00<00:00, 2.29MB/s]

scheduler_config.json: 100%

308/308 [00:00<00:00, 3.94kB/s]

config.json: 4.72k/? [00:00<00:00, 51.2kB/s]

text_encoder/model.safetensors: 100%

492M/492M [00:18<00:00, 18.3MB/s]

safety_checker/model.safetensors: 100%

1.22G/1.22G [00:33<00:00, 28.7MB/s]

special_tokens_map.json: 100%

472/472 [00:00<00:00, 5.78kB/s]

unet/diffusion_pytorch_model.safetensors: 100%

3.44G/3.44G [00:35<00:00, 122MB/s]

config.json: 100%

743/743 [00:00<00:00, 49.3kB/s]

vae/diffusion_pytorch_model.safetensors: 100%

335M/335M [00:21<00:00, 28.3MB/s]

config.json: 100%

547/547 [00:00<00:00, 28.2kB/s]

Loading pipeline components...: 100%

7/7 [00:24<00:00, 2.49s/it]

`torch_dtype` is deprecated! Use `dtype` instead!

```
output_dir = "generated_images"
os.makedirs(output_dir, exist_ok=True)
```

```
prompts = [
    "A futuristic city at night",
    "A cat chasing a mouse",
    "A sunset over snowy mountains",
    "A cyberpunk street scene",
    "A lava dragon attacking a castle"
]
```

```
for i, prompt in enumerate(prompts):
    image = pipe(prompt).images[0]
    image.save(f"{output_dir}/image_{i+1}.png")
    display(image)
```


100%

50/50 [00:08<00:00, 7.09it/s]



100%

50/50 [00:08<00:00, 6.47it/s]



100%

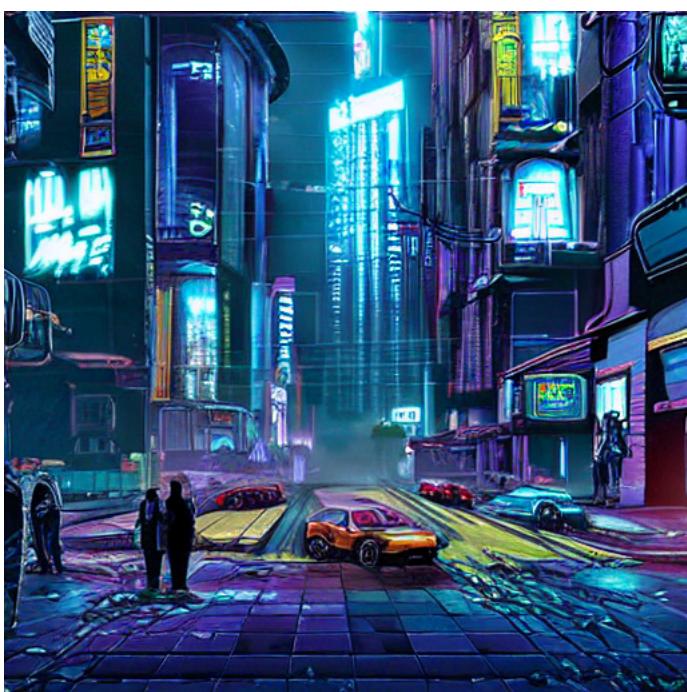
50/50 [00:08<00:00, 5.23it/s]





100%

50/50 [00:09<00:00, 6.86it/s]



100%

50/50 [00:07<00:00, 6.73it/s]





```
!pip install diffusers transformers accelerate torch safetensors pillow
```

```
Requirement already satisfied: diffusers<0.36.1> in /usr/local/lib/python3.12/dist-packages (0.36.0)
Requirement already satisfied: transformers<4.57.3> in /usr/local/lib/python3.12/dist-packages (4.57.3)
Requirement already satisfied: accelerate<0.12.0> in /usr/local/lib/python3.12/dist-packages (1.12.0)
Requirement already satisfied: torch<2.0.0> in /usr/local/lib/python3.12/dist-packages (2.9.0+cu126)
Requirement already satisfied: safetensors<0.7.0> in /usr/local/lib/python3.12/dist-packages (0.7.0)
Requirement already satisfied: pillow<3.20.2> in /usr/local/lib/python3.12/dist-packages (11.3.0)
Requirement already satisfied: requests<2.32.4> in /usr/local/lib/python3.12/dist-packages (from diffusers) (8.7.1)
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Requirement already satisfied: tokenizers<0.22.2> in /usr/local/lib/python3.12/dist-packages (from transformers) (0.22.2)
Requirement already satisfied: tqdm<4.67.1> in /usr/local/lib/python3.12/dist-packages (from transformers) (4.67.1)
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Requirement already satisfied: setuptools<75.2.0> in /usr/local/lib/python3.12/dist-packages (from torch) (75.2.0)
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Requirement already satisfied: networkx<3.6.1> in /usr/local/lib/python3.12/dist-packages (from torch) (3.6.1)
Requirement already satisfied: jinja2<3.1.6> in /usr/local/lib/python3.12/dist-packages (from torch) (3.1.6)
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Requirement already satisfied: nvidia-cuda-runtime-cu12==12.6.77 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.77)
Requirement already satisfied: nvidia-cuda-cupti-cu12==12.6.80 in /usr/local/lib/python3.12/dist-packages (from torch) (12.6.80)
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Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.12/dist-packages (from requests->diffusers) (2.5.0)
```

```
import torch
from diffusers import StableDiffusionPipeline

model_id = "runwayml/stable-diffusion-v1-5"

pipe = StableDiffusionPipeline.from_pretrained(
    model_id,
    torch_dtype=torch.float16
).to("cuda")
```

Loading pipeline components...: 100%

7/7 [00:31<00:00, 3.34s/it]

```
labels = [
    "Normal anatomy - healthy lungs, age & gender variations",
    "Infectious patterns - bacterial/viral pneumonia, COVID-like opacities",
    "Lung opacities - focal, diffuse, ground-glass, consolidations",
    "Pleural conditions - pleural effusion, pneumothorax",
    "Structural lesions - nodules, masses, fibrosis",
    "Cardiac findings - cardiomegaly, vascular congestion",
    "Medical devices - tubes, catheters, pacemakers",
    "Imaging artifacts - noise, motion blur, exposure issues",
    "View & positioning - PA/AP views, rotation, supine/erect",
    "Domain shift - scanner, hospital, and resolution variations"
]
```

```
import os
import re

def clean_label(label):
    return re.sub(r'^[a-zA-Z0-9_]', '_', label.split("-")[0].strip())

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

clean_labels = {}

for label in labels:
    folder = clean_label(label)
    clean_labels[label] = folder
    os.makedirs(os.path.join(base_dir, folder), exist_ok=True)
```

```
variation_descriptions = [
    "very mild and early-stage findings",
    "mild but clearly visible clinical findings",
    "moderate severity with noticeable abnormalities",
    "severe and advanced pathological findings",
    "critical condition with extensive abnormalities"
]
```

```
def build_prompt(label, i):
    return f"""
A high-resolution clinical chest X-ray image showing {label}.
The case represents {variation_descriptions[i-1]}.
The image should be medically accurate, realistic, and suitable for diagnostic use.
Hospital imaging style, sharp anatomical details, proper contrast,
no artistic effects, no cartoons, professional medical scan.
```

```
"""
from PIL import Image

for label in labels:
    folder = clean_labels[label]

    for i in range(1, 6):
        prompt = build_prompt(label, i)

        image = pipe(
            prompt,
            num_inference_steps=50,
            guidance_scale=8.5
        ).images[0]

        filename = f"{folder}_{i}.png"
        path = os.path.join(base_dir, folder, filename)
        image.save(path)

print(f"Saved: {path}")

```



```
100% 50/50 [00:08<00:00, 5.15it/s]
Saved: /content/xray_dataset/Normal_anatomy/Normal_anatomy_1.png
100% 50/50 [00:10<00:00, 5.55it/s]
Saved: /content/xray_dataset/Normal_anatomy/Normal_anatomy_2.png
100% 50/50 [00:07<00:00, 6.68it/s]
Saved: /content/xray_dataset/Normal_anatomy/Normal_anatomy_3.png
100% 50/50 [00:09<00:00, 6.92it/s]
Saved: /content/xray_dataset/Normal_anatomy/Normal_anatomy_4.png
100% 50/50 [00:07<00:00, 6.98it/s]
Token indices sequence length is longer than the specified maximum sequence length for this model (79 > 77). Running this sequence through the model will result in indexing errors
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['scan .']
Saved: /content/xray_dataset/Normal_anatomy/Normal_anatomy_5.png
100% 50/50 [00:07<00:00, 7.00it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['.']
Saved: /content/xray_dataset/Infectious_patterns/Infectious_patterns_1.png
100% 50/50 [00:07<00:00, 6.95it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['medical scan .']
Saved: /content/xray_dataset/Infectious_patterns/Infectious_patterns_2.png
100% 50/50 [00:10<00:00, 6.08it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['.']
Saved: /content/xray_dataset/Infectious_patterns/Infectious_patterns_3.png
100% 50/50 [00:07<00:00, 6.91it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['scan .']
Saved: /content/xray_dataset/Infectious_patterns/Infectious_patterns_4.png
100% 50/50 [00:07<00:00, 6.86it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['professional medical scan .']
Saved: /content/xray_dataset/Infectious_patterns/Infectious_patterns_5.png
100% 50/50 [00:07<00:00, 6.86it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['medical scan .']
Saved: /content/xray_dataset/Lung_opacities/Lung_opacities_1.png
100% 50/50 [00:07<00:00, 6.84it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: [, professional medical scan .]
Saved: /content/xray_dataset/Lung_opacities/Lung_opacities_2.png
100% 50/50 [00:07<00:00, 6.84it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['medical scan .']
Saved: /content/xray_dataset/Lung_opacities/Lung_opacities_3.png
100% 50/50 [00:07<00:00, 6.82it/s]
The following part of your input was truncated because CLIP can only handle sequences up to 77 tokens: ['professional medical scan .']
```

```
# Install CLIP properly
!pip install ftfy regex tqdm
!pip install git+https://github.com/openai/CLIP.git
```

```
import torch
import clip
import os
from PIL import Image

# Device
device = "cuda" if torch.cuda.is_available() else "cpu"

# Load CLIP model
model, preprocess = clip.load("ViT-B/32", device=device)

# Your medical labels
labels = [
    "Normal anatomy - healthy lungs, age & gender variations",
    "Abnormal anatomy - findings such as infiltrates, nodules, or fractures"]
```

```

"Infectious patterns - bacterial/viral pneumonia, COVID-like opacities",
"Lung opacities - focal, diffuse, ground-glass, consolidations",
"Pleural conditions - pleural effusion, pneumothorax",
"Structural lesions - nodules, masses, fibrosis",
"Cardiac findings - cardiomegaly, vascular congestion",
"Medical devices - tubes, catheters, pacemakers",
"Imaging artifacts - noise, motion blur, exposure issues",
"View & positioning - PA/AP views, rotation, supine/erect",
"Domain shift - scanner, hospital, and resolution variations"
]

# Encode text labels
text_tokens = clip.tokenize(labels).to(device)
text_features = model.encode_text(text_tokens)

# Dataset path
dataset_path = "/content/xray_dataset"

# Classify all images
for folder in os.listdir(dataset_path):
    folder_path = os.path.join(dataset_path, folder)

    if not os.path.isdir(folder_path):
        continue

    print(f"\n📁 Folder: {folder}")

    for img_name in os.listdir(folder_path):
        img_path = os.path.join(folder_path, img_name)

        image = preprocess(Image.open(img_path).convert("RGB")).unsqueeze(0).to(device)

        with torch.no_grad():
            image_features = model.encode_image(image)
            similarity = (image_features @ text_features.T).softmax(dim=-1)
            best_match = similarity.argmax().item()

        print(f"{img_name} → {labels[best_match]}")

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Infectious_patterns_3.png → Normal anatomy - healthy lungs, age & gender variations
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Infectious_patterns_1.png → Medical devices - tubes, catheters, pacemakers
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Infectious_patterns_2.png → Medical devices - tubes, catheters, pacemakers
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