SIREN 水印迁移性测试任务报告

本报告是对论文《Towards Reliable Verification of Unauthorized Data Usage in Personalized Text-to-Image Diffusion Models》（IEEE S&P 2025）的代码仓库进行的迁移性测试：在宝可梦数据集上训练出的水印编码器、解码器，能否直接迁移到另一个Q版动漫数据集(Anime-Chibi-Dataset)上使用。

任务一：环境配置

1.1 拉取 SIREN 仓库

```
git clone https://github.com/AntigoneRandy/SIREN.git
```

1.2 配置 Conda 环境

```
conda create --name sirentest python=3.9
conda activate sirentest
pip install -r requirements.txt
```

任务二：数据预处理

2.1 下载 Anime-Chibi 数据集并随机筛选 500 张图片

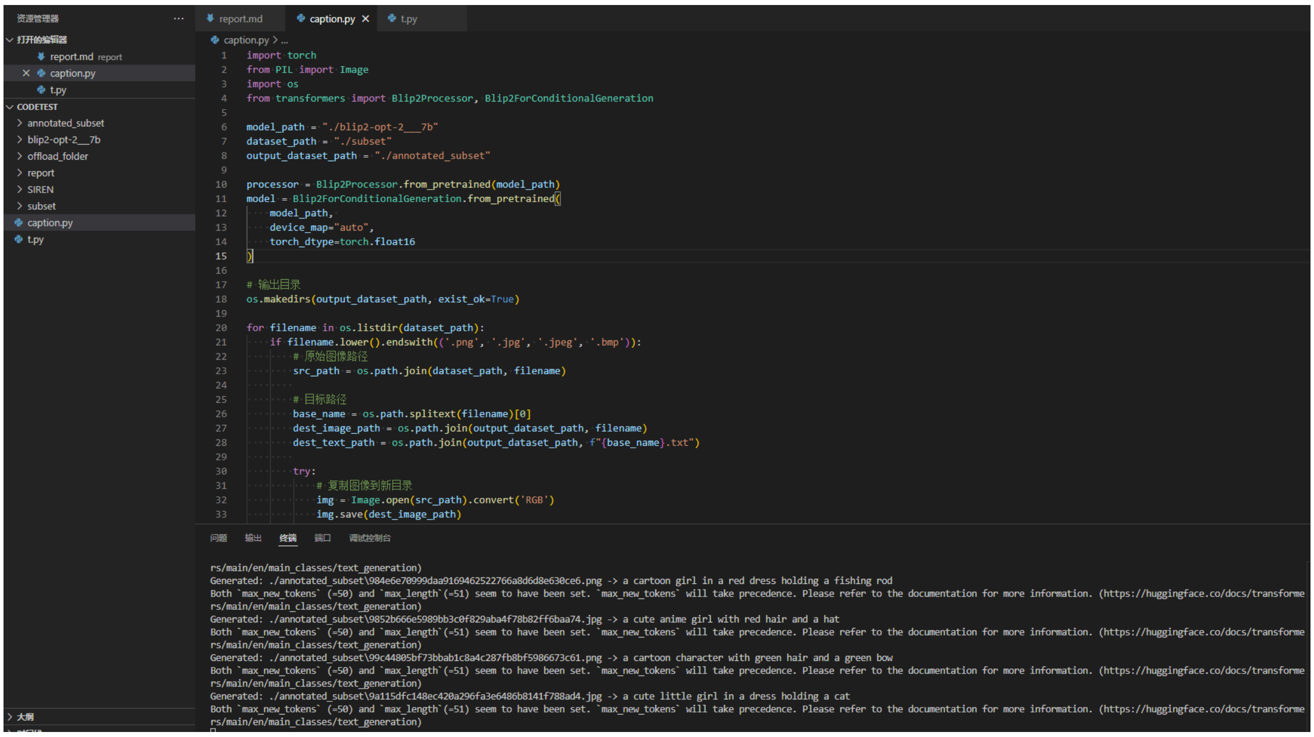
在下载目录下执行以下代码，然后将子集subset移动到代码目录下

```
import os
import shutil
import random

# 原始数据集路径
source_dir = "./download"
# 测试子集路径
target_dir = "./subset"

os.makedirs(target_dir, exist_ok=True)

image_files = [f for f in os.listdir(source_dir) if f.endswith(('.png',
'.jpg', '.jpeg'))]

selected_images = random.sample(image_files, 500)

for img in selected_images:
    shutil.copy(os.path.join(source_dir, img), target_dir)
```

2.2 使用 BLIP-2 生成 Caption

下载blip2-opt-2.7b到本地，运行`caption.py`使用NVIDIA GeForce RTX 4060 Laptop GPU进行半精度推理

```python
import torch
from PIL import Image
import os
from transformers import Blip2Processor, Blip2ForConditionalGeneration

model_path = "./blip2-opt-2___7b"
dataset_path = "./subset"
output_dataset_path = "./annotated_subset"

processor = Blip2Processor.from_pretrained(model_path)
model = Blip2ForConditionalGeneration.from_pretrained(
    model_path,
    device_map="auto",
    torch_dtype=torch.float16
)

# 输出目录
os.makedirs(output_dataset_path, exist_ok=True)

for filename in os.listdir(dataset_path):
    if filename.lower().endswith(('.png', '.jpg', '.jpeg', '.bmp')):
        # 原始图像路径
        src_path = os.path.join(dataset_path, filename)

        # 目标路径
        base_name = os.path.splitext(filename)[0]
        dest_image_path = os.path.join(output_dataset_path, filename)
        dest_text_path = os.path.join(output_dataset_path, f"{base_name}.txt")

        try:
            # 复制图像到新目录
            img = Image.open(src_path).convert('RGB')
            img.save(dest_image_path)

            # 生成caption
            inputs = processor(
                images=img,
                return_tensors="pt"
            ).to(model.device, torch.float16)

            generated_ids = model.generate(**inputs, max_new_tokens=50)
            caption = processor.batch_decode(
                generated_ids,
                skip_special_tokens=True
            )[0].strip()

            # 保存文本标注
            with open(dest_text_path, 'w') as f:
                f.write(caption)

            print(f"Generated: {dest_image_path} -> {caption}")
        except Exception as e:
            print(f"Error processing {filename}: {str(e)}")
```

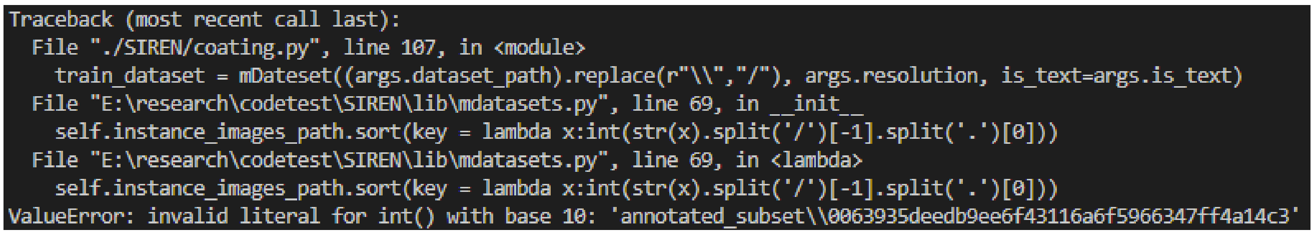


```python
import torch
from PIL import Image
import os
from transformers import Blip2Processor, Blip2ForConditionalGeneration

model_path = "./blip2-opt-2___7b"
dataset_path = "./subset"
output_dataset_path = "./annotated_subset"

processor = Blip2Processor.from_pretrained(model_path)
model = Blip2ForConditionalGeneration.from_pretrained(
    model_path,
    device_map="auto",
    torch_dtype=torch.float16
)

# 输出目录
os.makedirs(output_dataset_path, exist_ok=True)

for filename in os.listdir(dataset_path):
    if filename.lower().endswith(('.png', '.jpg', '.jpeg', '.bmp')):
        # 原始图像路径
        src_path = os.path.join(dataset_path, filename)
        
        # 目标路径
        base_name = os.path.splitext(filename)[0]
        dest_image_path = os.path.join(output_dataset_path, filename)
        dest_text_path = os.path.join(output_dataset_path, f"{base_name}.txt")
        
        try:
            # 复制图像到新目录
            img = Image.open(src_path).convert('RGB')
            img.save(dest_image_path)
```

```
rs/main/en/main_classes/text_generation)
Generated: ./annotated_subset\984e6e70999daa9169462522766a8d6d8e630ce6.png -> a cartoon girl in a red dress holding a fishing rod
Both `max_new_tokens` (=50) and `max_length`(=51) seem to have been set. `max_new_tokens` will take precedence. Please refer to the documentation for more information. (https://huggingface.co/docs/transforme
rs/main/en/main_classes/text_generation)
Generated: ./annotated_subset\9852b666e5989bb3c0f829aba4f78b82ff6baa74.jpg -> a cute anime girl with red hair and a hat
Both `max_new_tokens` (=50) and `max_length`(=51) seem to have been set. `max_new_tokens` will take precedence. Please refer to the documentation for more information. (https://huggingface.co/docs/transforme
rs/main/en/main_classes/text_generation)
Generated: ./annotated_subset\99c44805bf73bbab1c8a4c287fb8bf5986673c61.png -> a cartoon character with green hair and a green bow
Both `max_new_tokens` (=50) and `max_length`(=51) seem to have been set. `max_new_tokens` will take precedence. Please refer to the documentation for more information. (https://huggingface.co/docs/transforme
rs/main/en/main_classes/text_generation)
Generated: ./annotated_subset\9a115dfc148ec420a296fa3e6486b8141f788ad4.jpg -> a cute little girl in a dress holding a cat
Both `max_new_tokens` (=50) and `max_length`(=51) seem to have been set. `max_new_tokens` will take precedence. Please refer to the documentation for more information. (https://huggingface.co/docs/transforme
rs/main/en/main_classes/text_generation)
```

2.4 添加 SIREN 水印

```
python ./SIREN/coating.py --dataset_path "./annotated_subset" --
decoder_checkpoint "./SIREN/ckpt/pokemon_decoder.pth" --encoder_checkpoint
"./SIREN/ckpt/pokemon_encoder.pth" --output_path "./coated_dataset" --is_text
--gpu_id 0
```

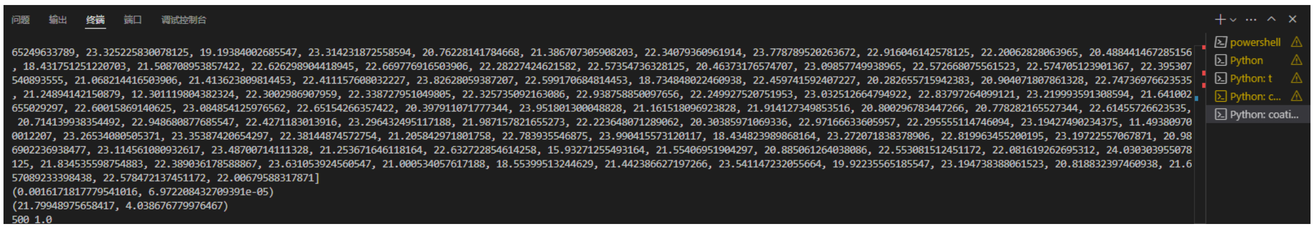


```
Traceback (most recent call last):
  File "./SIREN/coating.py", line 107, in <module>
    train_dataset = mDateset((args.dataset_path).replace(r"\\","/"), args.resolution, is_text=args.is_text)
  File "E:\research\codetest\SIREN\lib\mdatasets.py", line 69, in __init__
    self.instance_images_path.sort(key = lambda x:int(str(x).split('/')[-1].split('.')[0]))
  File "E:\research\codetest\SIREN\lib\mdatasets.py", line 69, in <lambda>
    self.instance_images_path.sort(key = lambda x:int(str(x).split('/')[-1].split('.')[0]))
ValueError: invalid literal for int() with base 10: 'annotated_subset\\0063935deedb9ee6f43116a6f5966347ff4a14c3'
```

运行发现路径转换有问题，改一下代码

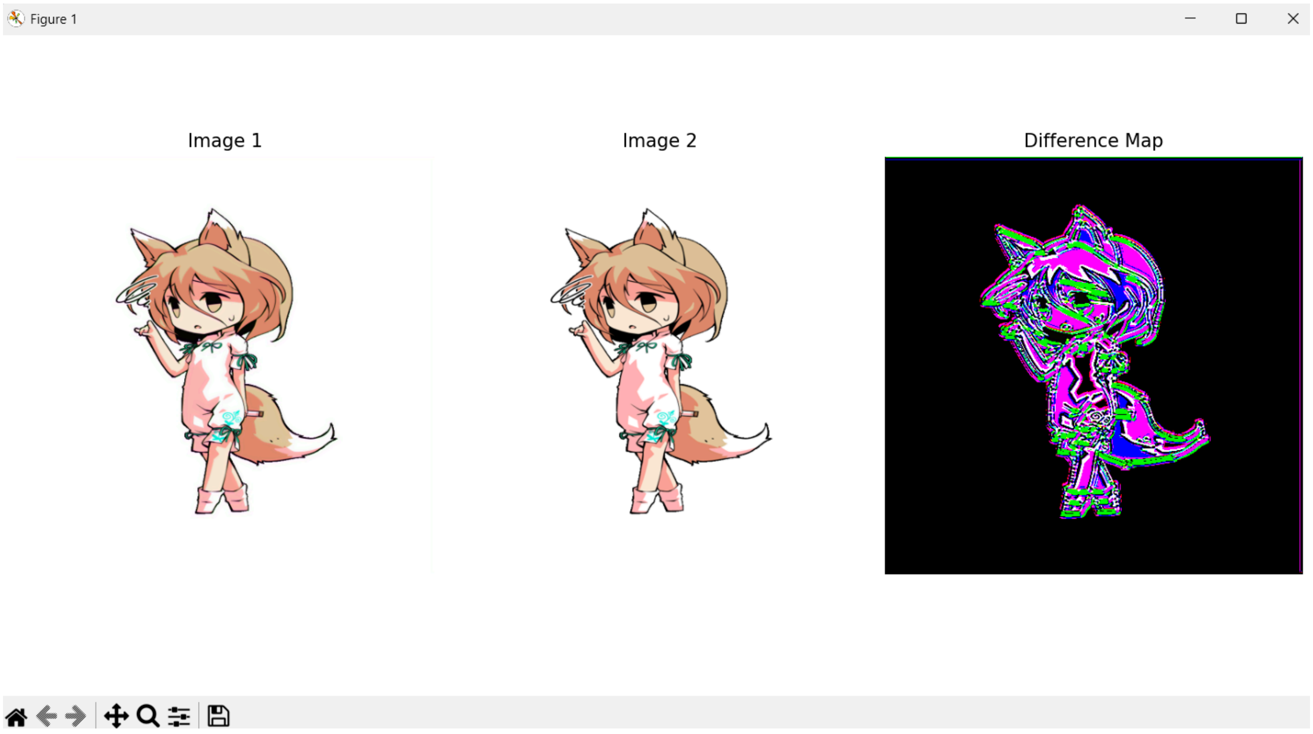
```
self.instance_images_path.sort(key = lambda x:int(str(x).split('\\')
[-1].split('.')[0],16))
self.instance_text_path.sort(key = lambda x:int(str(x).split('\\')
[-1].split('.')[0],16))
```

运行成功



```
65249633789, 23.325225830078125, 19.19384002685547, 23.314231872558594, 20.76228141784668, 21.386707305908203, 22.34079360961914, 23.778789520263672, 22.916046142578125, 22.20062828063965, 20.488441467285156
, 18.431751251220703, 21.508708953857422, 22.626298904418945, 22.669776916503906, 22.28227424621582, 22.57354736328125, 20.46373176574707, 23.09857749938965, 22.572668075561523, 22.574705123901367, 22.395307
540893555, 21.068214416503906, 21.413623809814453, 22.411157608032227, 23.82628059387207, 22.599170684814453, 18.734848022460938, 22.459741592407227, 20.282655715942383, 20.904071807861328, 22.74736976623535
, 21.24894142150879, 12.301119804382324, 22.3002986907959, 22.338727951049805, 22.325735092163086, 22.938758850097656, 22.249927520751953, 23.032512664794922, 22.83797264099121, 23.219993591308594, 21.641002
655029297, 22.60015869140625, 23.084854125976562, 22.65154266357422, 20.397911071777344, 23.951801300048828, 21.161518096923828, 21.914127349853516, 20.800296783447266, 20.778282165527344, 22.61455726623535,
 20.714139938354492, 22.948680877685547, 22.4271183013916, 23.296432495117188, 21.987157821655273, 22.223648071289062, 20.30385971069336, 22.97166633605957, 22.295555114746094, 23.19427490234375, 11.49380970
0012207, 23.26534080505371, 23.35387420654297, 22.38144874572754, 21.205842971801758, 22.783935546875, 23.990415573120117, 18.434823989868164, 23.272071838378906, 22.819963455200195, 23.19722557067871, 20.98
6902236938477, 23.114561080932617, 23.48700714111328, 21.253671646118164, 22.632722854614258, 15.93271255493164, 21.55406951904297, 20.885061264038086, 22.553081512451172, 22.081619262695312, 24.030303955078
125, 21.834535598754883, 22.389036178588867, 23.631053924560547, 21.000534057617188, 18.55399513244629, 21.442386627197266, 23.541147232055664, 19.92235565185547, 23.194738388061523, 20.818832397460938, 21.6
57089233398438, 22.578472137451172, 22.00679588317871]
(0.0016171817779541016, 6.972208432709391e-05)
(21.79948975658417, 4.038676779976467)
500 1.0
```

写个脚本（coated_dataset/diif.py）看看情况



说明水印生成正确

任务三：训练个性化模型与生成图片

3.1 使用 kohya-ss LoRA 仓库训练

```
训练使用NVIDIA GeForce RTX 4060 Laptop GPU，显存8G专用+8G共享=16G
由于本实验以学习为目的，基于显存及速度考虑，调整了微调参数使显存更低速度更快
由于显存不足，调整到了batch_size = 1并使用AdamW8bit优化器和network_dim=16
使用kohya-ss LoRA微调10epoch，根据loss变化决定所有模型微调5epoch
```

下载kohya-ss LoRA 仓库保存到sd-scripts

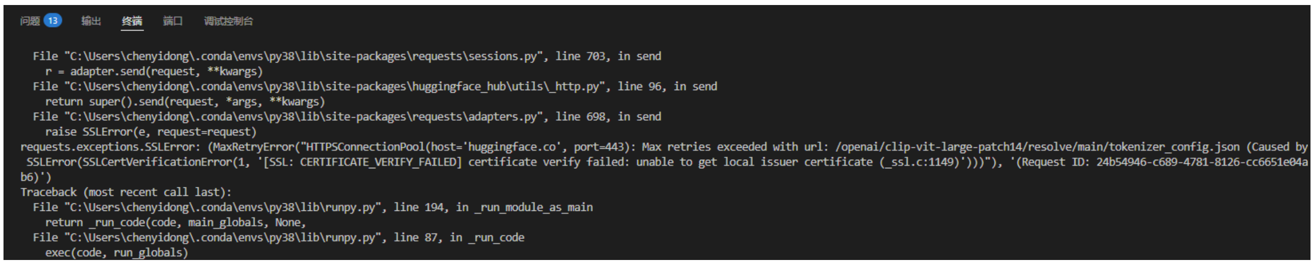
配置clean_pokemon.toml

```
[general]
enable_bucket = true

[[datasets]]
resolution = 512
batch_size = 1

  [[datasets.subsets]]
  image_dir = 'coated_dataset/original'
  caption_extension = '.txt'
  num_repeats = 1
```

coated_pokemon.toml同理

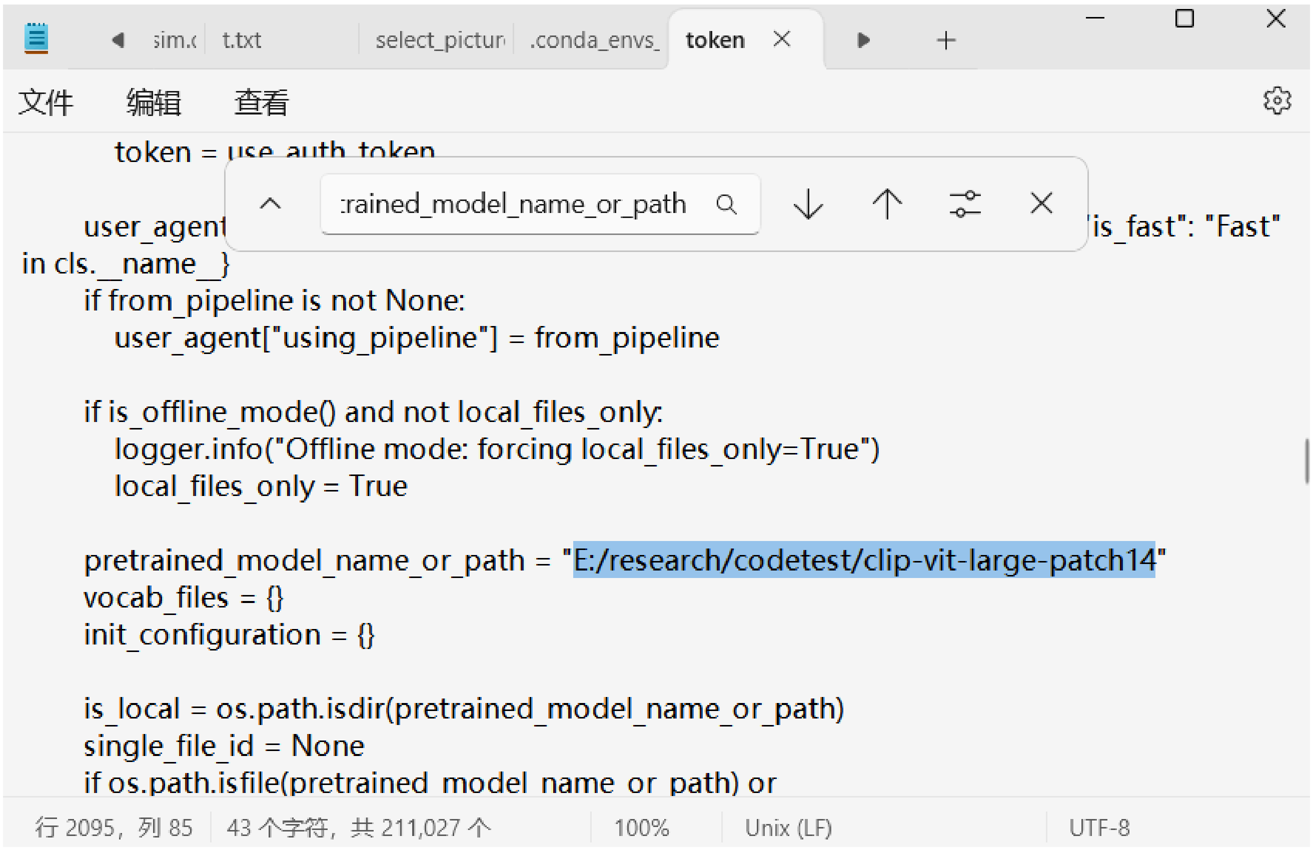
运行训练命令（windous PS使用`换行，下同）

```
accelerate launch --gpu_ids='0'  sd-scripts/train_network.py `
    --pretrained_model_name_or_path="stable-diffusion-v1-5" `
    --dataset_config="clean.toml" `
    --output_dir="./kohya_lora_clean" `
    --output_name="kohya_lora_clean" `
    --save_model_as=safetensors `
    --prior_loss_weight=1.0 `
    --max_train_epochs=5 `
    --learning_rate=1e-4 `
    --optimizer_type="AdamW8bit" `
    --mixed_precision="no" `
    --save_every_n_epochs=10 `
    --network_module=networks.lora `
    --network_dim=16 `
    --network_alpha=8 `
    --gradient_accumulation_steps=1 `
    --cache_latents

accelerate launch --gpu_ids='0'  sd-scripts/train_network.py `
    --pretrained_model_name_or_path="stable-diffusion-v1-5" `
    --dataset_config="coated.toml" `
    --output_dir="./kohya_lora_coated" `
    --output_name="kohya_lora_coated" `
    --save_model_as=safetensors `
    --prior_loss_weight=1.0 `
    --max_train_epochs=5 `
    --learning_rate=1e-4 `
    --optimizer_type="AdamW8bit" `
    --mixed_precision="fp16" `
    --save_every_n_epochs=10 `
    --network_module=networks.lora `
    --network_dim=16 `
    --network_alpha=8 `
    --gradient_accumulation_steps=1 `
    --cache_latents
```



```
  File "C:\Users\chenyidong\.conda\envs\py38\lib\site-packages\requests\sessions.py", line 703, in send
    r = adapter.send(request, **kwargs)
  File "C:\Users\chenyidong\.conda\envs\py38\lib\site-packages\huggingface_hub\utils\_http.py", line 96, in send
    return super().send(request, *args, **kwargs)
  File "C:\Users\chenyidong\.conda\envs\py38\lib\site-packages\requests\adapters.py", line 698, in send
    raise SSLError(e, request=request)
requests.exceptions.SSLError: (MaxRetryError("HTTPSConnectionPool(host='huggingface.co', port=443): Max retries exceeded with url: /openai/clip-vit-large-patch14/resolve/main/tokenizer_config.json (Caused by
 SSLError(SSLCertVerificationError(1, '[SSL: CERTIFICATE_VERIFY_FAILED] certificate verify failed: unable to get local issuer certificate (_ssl.c:1149)')))"), '(Request ID: 24b54946-c689-4781-8126-cc6651e04a
b6)')
Traceback (most recent call last):
  File "C:\Users\chenyidong\.conda\envs\py38\lib\runpy.py", line 194, in _run_module_as_main
    return _run_code(code, main_globals, None,
  File "C:\Users\chenyidong\.conda\envs\py38\lib\runpy.py", line 87, in _run_code
    exec(code, run_globals)
```

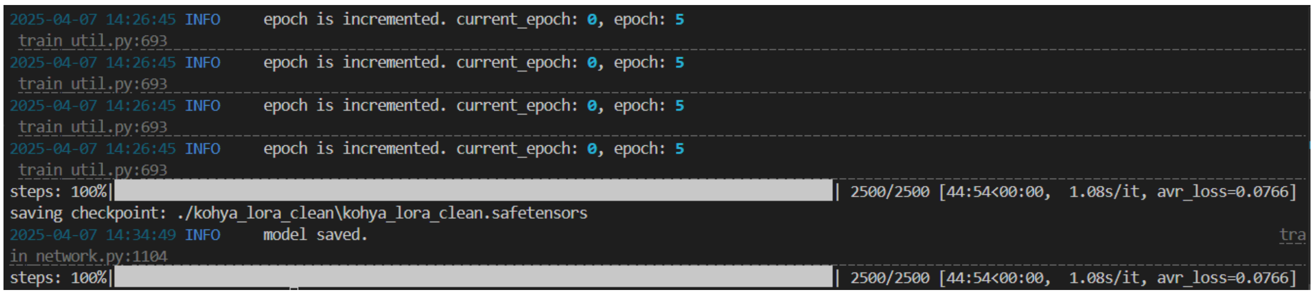
连不上huggingface，无法下载模型。手动下载模型，更改Lib\site-packages\transformers\tokenization_utils_base.py。



```
        token = use_auth_token

    user_agent                                              "is_fast": "Fast"
in cls.__name__}
    if from_pipeline is not None:
        user_agent["using_pipeline"] = from_pipeline

    if is_offline_mode() and not local_files_only:
        logger.info("Offline mode: forcing local_files_only=True")
        local_files_only = True

    pretrained_model_name_or_path = "E:/research/codetest/clip-vit-large-patch14"
    vocab_files = {}
    init_configuration = {}

    is_local = os.path.isdir(pretrained_model_name_or_path)
    single_file_id = None
    if os.path.isfile(pretrained_model_name_or_path) or
```

行 2095，列 85 | 43 个字符，共 211,027 个 | 100% | Unix (LF) | UTF-8

训练成功

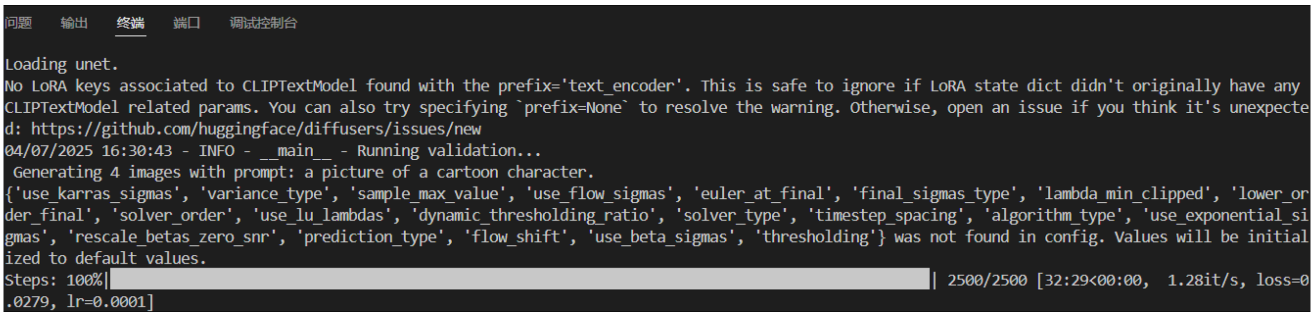


```
2025-04-07 14:26:45 INFO     epoch is incremented. current_epoch: 0, epoch: 5
 train_util.py:693
2025-04-07 14:26:45 INFO     epoch is incremented. current_epoch: 0, epoch: 5
 train_util.py:693
2025-04-07 14:26:45 INFO     epoch is incremented. current_epoch: 0, epoch: 5
 train_util.py:693
2025-04-07 14:26:45 INFO     epoch is incremented. current_epoch: 0, epoch: 5
 train_util.py:693
steps: 100%|████████████████████████████████████████| 2500/2500 [44:54<00:00,  1.08s/it, avr_loss=0.0766]
saving checkpoint: ./kohya_lora_clean\kohya_lora_clean.safetensors
2025-04-07 14:34:49 INFO     model saved.                                                          tra
in network.py:1104
steps: 100%|████████████████████████████████████████| 2500/2500 [44:54<00:00,  1.08s/it, avr_loss=0.0766]
```

3.2 使用 diffusers 官方仓库训练

```
# 2. 训练命令
accelerate launch train_dreambooth_lora.py `
  --pretrained_model_name_or_path="stable-diffusion-v1-5" `
  --output_dir="./diffusions_lora_clean" `
  --instance_data_dir="coated_dataset/original"
  --instance_prompt="a picture of a cute anime character" `
  --resolution=512 `
  --train_batch_size=1 `
  --gradient_accumulation_steps=1 `
```

```
    --learning_rate=1e-4 `
    --num_train_epochs=5 `
    --validation_prompt="a picture of a cute anime character" `
    --validation_epochs=10 `
    --rank=16 `
    --seed=42 `
    --use_8bit_adam

accelerate launch train_dreambooth_lora.py `
    --pretrained_model_name_or_path="stable-diffusion-v1-5" `
    --output_dir="./diffusions_lora_coated" `
    --instance_data_dir="coated_dataset/coating"
    --instance_prompt="a picture of a cute anime character" `
    --resolution=512 `
    --train_batch_size=1 `
    --gradient_accumulation_steps=1 `
    --learning_rate=1e-4 `
    --num_train_epochs=5 `
    --validation_prompt="a picture of a cute anime character" `
    --validation_epochs=10 `
    --rank=16 `
    --seed=42 `
    --use_8bit_adam
```



```
Loading unet.
No LoRA keys associated to CLIPTextModel found with the prefix='text_encoder'. This is safe to ignore if LoRA state dict didn't originally have any
CLIPTextModel related params. You can also try specifying `prefix=None` to resolve the warning. Otherwise, open an issue if you think it's unexpecte
d: https://github.com/huggingface/diffusers/issues/new
04/07/2025 16:30:43 - INFO - __main__ - Running validation...
 Generating 4 images with prompt: a picture of a cartoon character.
{'use_karras_sigmas', 'variance_type', 'sample_max_value', 'use_flow_sigmas', 'euler_at_final', 'final_sigmas_type', 'lambda_min_clipped', 'lower_or
der_final', 'solver_order', 'use_lu_lambdas', 'dynamic_thresholding_ratio', 'solver_type', 'timestep_spacing', 'algorithm_type', 'use_exponential_si
gmas', 'rescale_betas_zero_snr', 'prediction_type', 'flow_shift', 'use_beta_sigmas', 'thresholding'} was not found in config. Values will be initial
ized to default values.
Steps: 100%|████████████████████████████████████████████████| 2500/2500 [32:29<00:00,  1.28it/s, loss=0
.0279, lr=0.0001]
```

3.3 生成图片

运行`gen_evaluate_pic.py`用四种权重分别生成图片，命名为{modelIndex}_{promptIndex}.png 由于本实验已经引入clip，可以方便地使用clip计算图文相似度分数

```python
from diffusers import StableDiffusionPipeline
import torch
from PIL import Image
from transformers import CLIPProcessor, CLIPModel
import os
import requests

# 加载 Stable Diffusion 模型
pipe = StableDiffusionPipeline.from_pretrained(
    "stable-diffusion-v1-5",
    torch_dtype=torch.float16
).to("cuda")
```

```
# 加载 CLIP 模型和处理器
clip_model = CLIPModel.from_pretrained("openai/clip-vit-large-patch14")
clip_processor = CLIPProcessor.from_pretrained("openai/clip-vit-large-
patch14")

# 定义权重文件和提示文本
weights = [
    "./kohya_lora_clean/kohya_lora_clean.safetensors",
    "./kohya_lora_coated/kohya_lora_coated.safetensors",
    "./diffusions_lora_clean/pytorch_lora_weights.safetensors",
    "./diffusions_lora_coated/pytorch_lora_weights.safetensors"
]
prompts = [
]

# 确保生成图片的目录存在
os.makedirs("gen_pic", exist_ok=True)

# 生成图片并计算图文相似度
for i in range(len(weights)):
    pipe.load_lora_weights(weights[i])
    for j in range(len(prompts)):
        # 生成图片
        image = pipe(prompts[j]).images[0]
        image_path = f"gen_pic/{i}_{j}.png"
        image.save(image_path)

        # 计算图文相似度
        try:
            # 加载本地图片
            image = Image.open(image_path)

            # 处理输入
            inputs = clip_processor(
                text=[prompts[j]],  # 使用对应的提示文本
                images=image,
                return_tensors="pt",
                padding=True
            )

            # 计算相似度
            outputs = clip_model(**inputs)
            logits_per_image = outputs.logits_per_image  # 图文相似度分数
            probs = logits_per_image.softmax(dim=1)      # 转换为概率

            print(f"Image {i}_{j}.png - Text: {prompts[j]}")
            print(f"Similarity Score: {logits_per_image.item():.4f}")
            print(f"Probability: {probs.item():.4f}\n")

        except Exception as e:
            print(f"Error processing image {i}_{j}.png: {e}")
```

3.4 方法对比

以下是针对kohya-ss与diffusers两个LoRA训练方法的实现和用法对比分析：

对比维度	kohya-ss LoRA	diffusers LoRA
数据集配置方式	TOML文件分层配置	命令行参数直接配置
数据集定义	通过`[[datasets.subsets]]`定义多数据集	`--instance_data_dir`单路径指定
提示词控制	依赖文本文件（.txt）与文件名	`--instance_prompt`参数
LoRA层级控制	通过`--network_dim`/`--network_alpha`	通过`--rank`参数控制
训练性能	显存9G左右，运行45min	显存4G左右，运行35min

- **kohya-ss**
  采用TOML分层配置：

  ```
  [[datasets.subsets]]
  image_dir = 'coated_dataset/original'
  caption_extension = '.txt'
  ```

  优势：支持多数据集混合训练 *局限*：需要预先组织文件结构

- **diffusers**
  完全通过命令行参数控制：

  ```
  --instance_data_dir="coated_dataset/original"
  --instance_prompt="a picture of..."
  ```

  优势：快速启动，适合单一概念微调
  局限：缺乏多数据集支持，提示词灵活性低

以下是每张图片的CLIP结果整理，按图片编号、文本提示、相似性分数和概率进行排列：

模型对应Index

- kohya_lora_clean：0
- kohya_lora_coated：1
- diffusions_lora_clean：2
- diffusions_lora_coated：3

按模型Index分类的CLIP结果表

模型Index	图片子编号	相似性分数	概率	人工打分(0-9)
0	0	19.8164	1.0000	4
0	1	24.4931	1.0000	3

模型Index	图片子编号	相似性分数	概率	人工打分(0-9)
0	2	26.7386	1.0000	3
1	0	27.1111	1.0000	2
1	1	28.8642	1.0000	4
1	2	18.9113	1.0000	3
2	0	26.7029	1.0000	3
2	1	29.3728	1.0000	5
2	2	22.3227	1.0000	4
3	0	23.7016	1.0000	2
3	1	28.0232	1.0000	2
3	2	23.9721	1.0000	2

每个模型图文相似度都很多，人工评价0，1，2号模型都差不多，3稍差。

任务四：测试结果

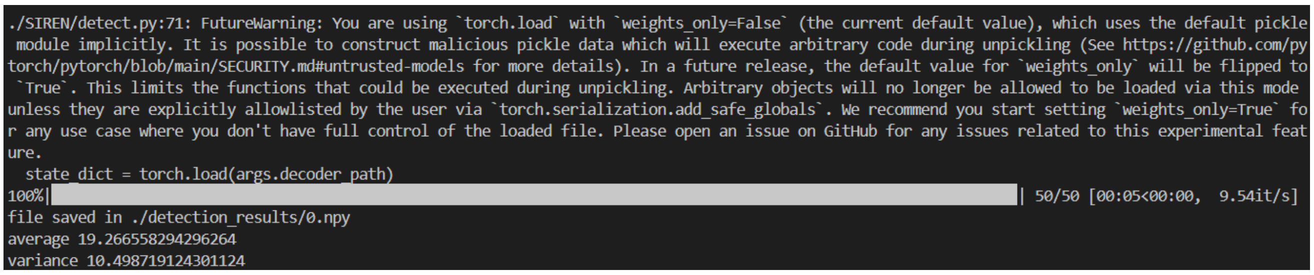
4.1 检测水印

再运行`gen_pics.py`每个模型生成50个图像，保存在./gen_pic/{modelIndex}文件夹下，并使用SIREN模型检测水印。

```
# 检测干净数据集
python ./SIREN/detect.py `
    --dataset_path "./gen_pic/0" `
    --decoder_path "./SIREN/ckpt/pokemon_decoder.pth" `
    --gpu_id 0 `
    --output_path "./detection_results" `
    --output_filename "0.npy"

python ./SIREN/detect.py `
    --dataset_path "./gen_pic/2" `
    --decoder_path "./SIREN/ckpt/pokemon_decoder.pth" `
    --gpu_id 0 `
    --output_path "./detection_results" `
    --output_filename "2.npy"

# 检测加水印数据集
python ./SIREN/detect.py `
    --dataset_path "./gen_pic/1" `
    --decoder_path "./SIREN/ckpt/pokemon_decoder.pth" `
    --gpu_id 0 `
    --output_path "./detection_results" `
    --output_filename "1.npy"
```

```
python ./SIREN/detect.py `
    --dataset_path "./gen_pic/3" `
    --decoder_path "./SIREN/ckpt/pokemon_decoder.pth" `
    --gpu_id 0 `
    --output_path "./detection_results" `
    --output_filename "3.npy"
```

```
file saved in ./detection_results/0.npy
average 19.266558294296264
variance 10.498719124301124

file saved in ./detection_results/2.npy
average 19.660686283111573
variance 8.915170050950627

file saved in ./detection_results/1.npy
average 17.062278861999513
variance 29.652935684822783

file saved in ./detection_results/3.npy
average 18.329211947917937
variance 31.769990669024267
```

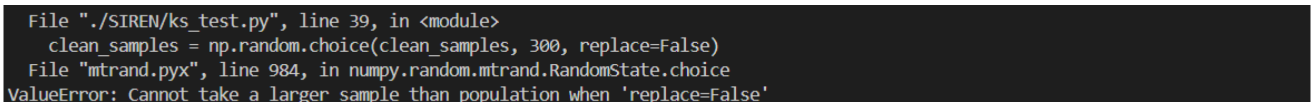


```
./SIREN/detect.py:71: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default value), which uses the default pickle
 module implicitly. It is possible to construct malicious pickle data which will execute arbitrary code during unpickling (See https://github.com/py
torch/pytorch/blob/main/SECURITY.md#untrusted-models for more details). In a future release, the default value for `weights_only` will be flipped to
 `True`. This limits the functions that could be executed during unpickling. Arbitrary objects will no longer be allowed to be loaded via this mode
unless they are explicitly allowlisted by the user via `torch.serialization.add_safe_globals`. We recommend you start setting `weights_only=True` fo
r any use case where you don't have full control of the loaded file. Please open an issue on GitHub for any issues related to this experimental feat
ure.
  state_dict = torch.load(args.decoder_path)
100%|██████████████████████████████████████████████████| 50/50 [00:05<00:00,  9.54it/s]
file saved in ./detection_results/0.npy
average 19.266558294296264
variance 10.498719124301124
```

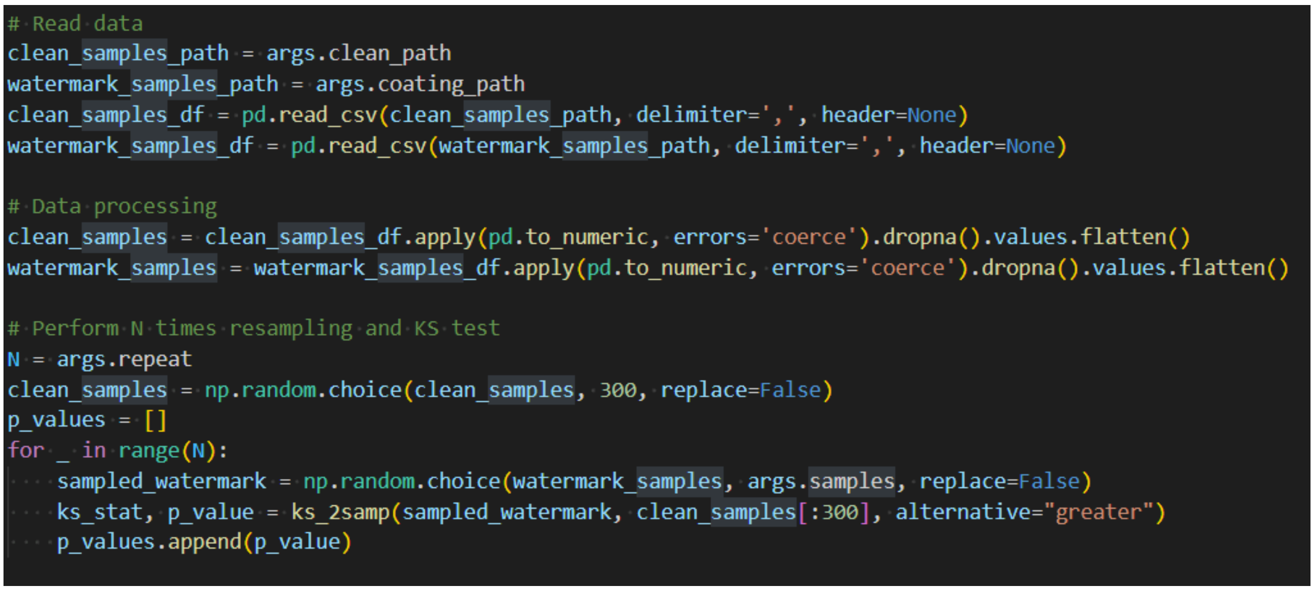
4.2 假设检验

```
python ./SIREN/ks_test.py `
    --clean_path "./detection_results/0.npy" `
    --coating_path "./detection_results/1.npy" `
    --output "./test_results/kohya.log"
    --repeat=100000
    --samples=50

python ./SIREN/ks_test.py `
    --clean_path "./detection_results/2.npy" `
    --coating_path "./detection_results/3.npy" `
    --output "./test_results/diffusers.log"
    --repeat=100000
    --samples=50
```

运行出错

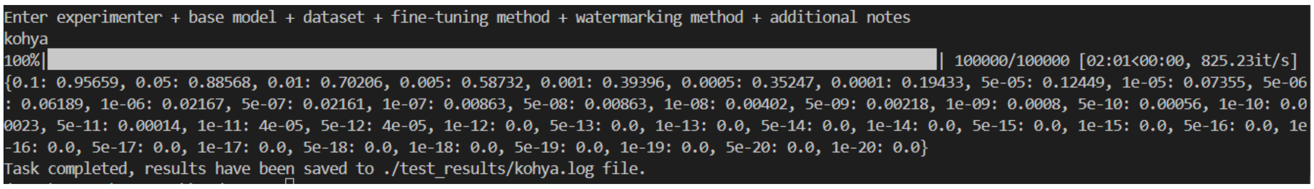


```
  File "./SIREN/ks_test.py", line 39, in <module>
    clean_samples = np.random.choice(clean_samples, 300, replace=False)
  File "mtrand.pyx", line 984, in numpy.random.mtrand.RandomState.choice
ValueError: Cannot take a larger sample than population when 'replace=False'
```



```
# Read data
clean_samples_path = args.clean_path
watermark_samples_path = args.coating_path
clean_samples_df = pd.read_csv(clean_samples_path, delimiter=',', header=None)
watermark_samples_df = pd.read_csv(watermark_samples_path, delimiter=',', header=None)

# Data processing
clean_samples = clean_samples_df.apply(pd.to_numeric, errors='coerce').dropna().values.flatten()
watermark_samples = watermark_samples_df.apply(pd.to_numeric, errors='coerce').dropna().values.flatten()

# Perform N times resampling and KS test
N = args.repeat
clean_samples = np.random.choice(clean_samples, 300, replace=False)
p_values = []
for _ in range(N):
    sampled_watermark = np.random.choice(watermark_samples, args.samples, replace=False)
    ks_stat, p_value = ks_2samp(sampled_watermark, clean_samples[:300], alternative="greater")
    p_values.append(p_value)
```

阅读代码发现`clean_samples = np.random.choice(clean_samples, 300, replace=False)`必须要取300个不同的，那就需要生成非常多的图片，那就改成replace=True允许重复取样吧。 为了方便查看进度，把repeat100000次ks_2samp的range改为trange,方便查看进度。



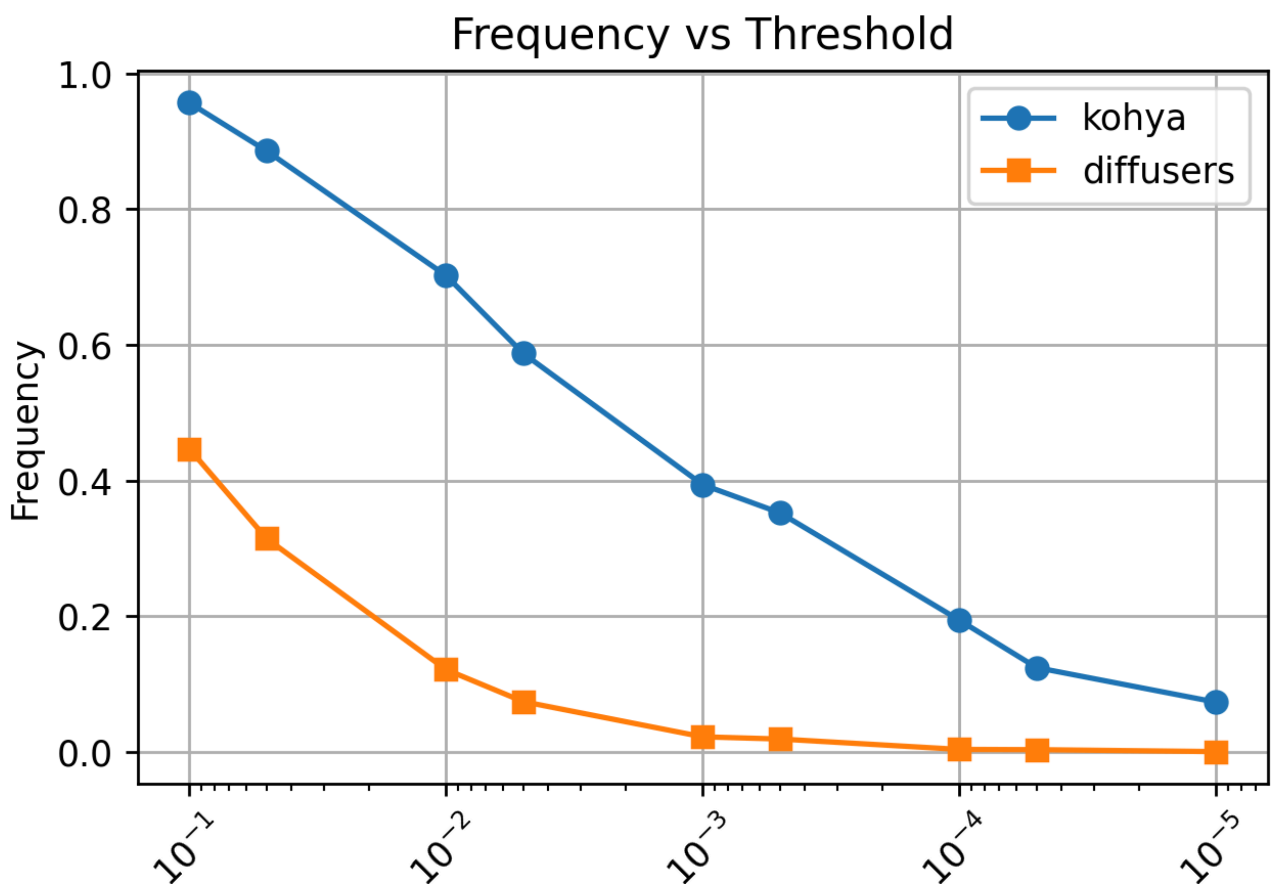
```
Enter experimenter + base model + dataset + fine-tuning method + watermarking method + additional notes
kohya
100%|██████████████████████████████████████████████████| 100000/100000 [02:01<00:00, 825.23it/s]
{0.1: 0.95659, 0.05: 0.88568, 0.01: 0.70206, 0.005: 0.58732, 0.001: 0.39396, 0.0005: 0.35247, 0.0001: 0.19433, 5e-05: 0.12449, 1e-05: 0.07355, 5e-06
: 0.06189, 1e-06: 0.02167, 5e-07: 0.02161, 1e-07: 0.00863, 5e-08: 0.00863, 1e-08: 0.00402, 5e-09: 0.00218, 1e-09: 0.0008, 5e-10: 0.00056, 1e-10: 0.0
0023, 5e-11: 0.00014, 1e-11: 4e-05, 5e-12: 4e-05, 1e-12: 0.0, 5e-13: 0.0, 1e-13: 0.0, 5e-14: 0.0, 1e-14: 0.0, 5e-15: 0.0, 1e-15: 0.0, 5e-16: 0.0, 1e
-16: 0.0, 5e-17: 0.0, 1e-17: 0.0, 5e-18: 0.0, 1e-18: 0.0, 5e-19: 0.0, 1e-19: 0.0, 5e-20: 0.0, 1e-20: 0.0}
Task completed, results have been saved to ./test_results/kohya.log file.
```

4.3 测试结果分析

阅读代码，易知代码的输出是p_values < threshold的频率

```
kohya
Time: 2025-04-08 15:08
Command: python ks_test_final.py --clean_path ./detection_results/0.npy --coating_path ./detection_results/1.npy --output ./test_results/kohya.log --repeat 100000 --samples 50
Clean_sample_size: 300, Watermark_sample_size: 50
Clean statistics: (19.446927938461304, 10.978389932422981)
Watermark statistics: (17.062278861999513, 29.65293568482278)
Threshold:
{0.1: 0.95659, 0.05: 0.88568, 0.01: 0.70206, 0.005: 0.58732, 0.001: 0.39396, 0.0005: 0.35247, 0.0001: 0.19433, 5e-05: 0.12449, 1e-05: 0.07355, 5e-06: 0.06189, 1e-06: 0.02167, 5e-07: 0.02161, 1e-07: 0.00863, 5e-08: 0.00863, 1e-08: 0.00402, 5e-09: 0.00218, 1e-09: 0.0008, 5e-10: 0.00056, 1e-10: 0.00023, 5e-11: 0.00014, 1e-11: 4e-05, 5e-12: 4e-05, 1e-12: 0.0, 5e-13: 0.0, 1e-13: 0.0, 5e-14: 0.0, 1e-14: 0.0, 5e-15: 0.0, 1e-15: 0.0, 5e-16: 0.0, 1e-16: 0.0, 5e-17: 0.0, 1e-17: 0.0, 5e-18: 0.0, 1e-18: 0.0, 5e-19: 0.0, 1e-19: 0.0, 5e-20: 0.0, 1e-20: 0.0}

diffusers
```

```
Time: 2025-04-08 15:09
Command: python ks_test_final.py --clean_path ./detection_results/2.npy --
coating_path ./detection_results/3.npy --output ./test_results/diffusers.log -
-repeat 100000 --samples 50
Clean_sample_size: 300, Watermark_sample_size: 50
Clean statistics: (19.801754382451374, 7.58085748970816)
Watermark statistics: (18.329211947917937, 31.769990669024267)
Threshold:
{0.1: 0.44682, 0.05: 0.31459, 0.01: 0.12158, 0.005: 0.07437, 0.001: 0.02254,
0.0005: 0.0193, 0.0001: 0.00396, 5e-05: 0.0036, 1e-05: 0.00073, 5e-06:
0.00059, 1e-06: 0.00024, 5e-07: 8e-05, 1e-07: 1e-05, 5e-08: 1e-05, 1e-08: 1e-
05, 5e-09: 0.0, 1e-09: 0.0, 5e-10: 0.0, 1e-10: 0.0, 5e-11: 0.0, 1e-11: 0.0,
5e-12: 0.0, 1e-12: 0.0, 5e-13: 0.0, 1e-13: 0.0, 5e-14: 0.0, 1e-14: 0.0, 5e-15:
0.0, 1e-15: 0.0, 5e-16: 0.0, 1e-16: 0.0, 5e-17: 0.0, 1e-17: 0.0, 5e-18: 0.0,
1e-18: 0.0, 5e-19: 0.0, 1e-19: 0.0, 5e-20: 0.0, 1e-20: 0.0}
```



数据解读

- 两次实验的干净样本大小均为 `300`，水印样本大小均为 `50`。
- **kohya**：干净样本的均值为 `19.446927938461304`，方差为 `10.978389932422981`；水印样本的均值为 `17.062278861999513`，方差为 `29.65293568482278`。
- **diffusers**：干净样本的均值为 `19.801754382451374`，方差为 `7.58085748970816`；水印样本的均值为 `18.329211947917937`，方差为 `31.769990669024267`。

可以看出，两次实验中水印样本的方差都明显大于干净样本的方差，水印样本的数据分布更为分散。

- **kohya**：在显著性水平0.05和0.01下，频率都很高（分别为0.88568和0.70206），说明分布差异显著。这表明水印嵌入对kohya_ss微调的模型输出的分布产生了显著影响。
- **diffusers**：在显著性水平0.1下，频率为0.44682，说明在44.68%的情况下，KS检验认为分布存在显著差异。 在显著性水平0.05和0.01下，频率分别为0.31459和0.12158，说明分布差异在更严格的显著性要求下不显著。 这表明水印嵌入对官方微调的模型输出的分布影响较小。

结论与分析

在 `kohya` 实验中，在常见的显著性水平（如 `0.05`）下，有较高比例的检验结果拒绝原假设，说明水印样本和干净样本之间可能存在更显著的差异；而在 `diffusers` 实验中，这种差异相对不那么显著。

两次实验在不同阈值下 `p` 值小于阈值的频率差异较大，这可能是由于：

1. `diffusers` 实验中的微调模型可能欠拟合，未完全学习水印特征。
2. `diffusers` 实验中，官方实现限制了提示词唯一。而由论文可知理论原理是设计一种可靠的涂层，使其在训练中被视为与学习任务有关的特征，唯一的提示词对应多种图像及其水印，可能干扰了水印特征的学习。

因此在宝可梦数据集上训练出的水印编码器、解码器有一定的迁移性，但是可能要考虑新数据集的类似程度和模型训练的程度。

代码提交

所有代码已提交至 GitHub 仓库：https://github.com/din0sauria/SIREN-codetest

运行说明

可参考本报告和README.md