1. Environment Setup

```
!pip install realesrgan
```

```
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib->filterpy->facexlib>=0
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.11/dist-packages (from matplotlib->filterpy->facexlib>=0.2.5
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.11/dist-packages (from matplotlib->filterpy->facexlib>=
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib->filterpy->facexlib>=
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.11/dist-packages (from matplotlib->filterpy->facexlib>=0
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.11/dist-packages (from matplotlib->filterpy->facexli
Downloading realesrgan-0.3.0-py3-none-any.whl (26 kB)
Downloading facexlib-0.3.0-py3-none-any.whl (59 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 59.6/59.6 kB 4.2 MB/s eta 0:00:00
Downloading gfpgan-1.3.8-py3-none-any.whl (52 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 52.2/52.2 kB 3.8 MB/s eta 0:00:00
Using cached nvidia_cublas_cu12-12.4.5.8-py3-none-manylinux2014_x86_64.whl (363.4 MB)
Using cached nvidia_cuda_cupti_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl (13.8 MB)
Using cached nvidia_cuda_nvrtc_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl (24.6 MB)
Using cached nvidia_cuda_runtime_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl (883 kB)
Using cached nvidia_cudnn_cu12-9.1.0.70-py3-none-manylinux2014_x86_64.whl (664.8 MB)
Using cached nvidia_cufft_cu12-11.2.1.3-py3-none-manylinux2014_x86_64.whl (211.5 MB)
Using cached nvidia_curand_cu12-10.3.5.147-py3-none-manylinux2014_x86_64.whl (56.3 MB)
Using cached nvidia_cusolver_cu12-11.6.1.9-py3-none-manylinux2014_x86_64.whl (127.9 MB)
Using cached nvidia_cusparse_cu12-12.3.1.170-py3-none-manylinux2014_x86_64.whl (207.5 MB)
Using cached nvidia_nvjitlink_cu12-12.4.127-py3-none-manylinux2014_x86_64.whl (21.1 MB)
Downloading addict-2.4.0-py3-none-any.whl (3.8 kB)
Downloading lmdb-1.6.2-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (297 kB)
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Downloading tb_nightly-2.20.0a20250414-py3-none-any.whl (5.5 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 5.5/5.5 MB 74.4 MB/s eta 0:00:00
Downloading yapf-0.43.0-py3-none-any.whl (256 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 256.2/256.2 kB 18.7 MB/s eta 0:00:00
Building wheels for collected packages: basicsr, filterpy
  Building wheel for basicsr (setup.py) ... done
  Created wheel for basicsr: filename=basicsr-1.4.2-py3-none-any.whl size=214818 sha256=b994176ac7f0e2bfb9615a3a0b9a7b090a79b53f0
  Stored in directory: /root/.cache/pip/wheels/6d/a4/b3/9f888ba88efcae6dd4bbce69832363de9c4051142674f779fa
  Building wheel for filterpy (setup.py) ... done
  Created wheel for filterpy: filename=filterpy-1.4.5-py3-none-any.whl size=110460 sha256=e6d62a8d35a1bf044472ebf941e5ec4b8ea476f
  Stored in directory: /root/.cache/pip/wheels/12/dc/3c/e12983eac132d00f82a20c6cbe7b42ce6e96190ef8fa2d15e1
Successfully built basicsr filterpy
Installing collected packages: lmdb, addict, yapf, nvidia-nvjitlink-cu12, nvidia-curand-cu12, nvidia-cufft-cu12, nvidia-cuda-runti
  Attempting uninstall: nvidia-nvjitlink-cu12
    Found existing installation: nvidia-nvjitlink-cu12 12.5.82
    Uninstalling nvidia-nvjitlink-cu12-12.5.82:
      Successfully uninstalled nvidia-nvjitlink-cu12-12.5.82
  Attempting uninstall: nvidia-curand-cu12
    Found existing installation: nvidia-curand-cu12 10.3.6.82
    Uninstalling nvidia-curand-cu12-10.3.6.82:
      Successfully uninstalled nvidia-curand-cu12-10.3.6.82
  Attempting uninstall: nvidia-cufft-cu12
    Found existing installation: nvidia-cufft-cu12 11.2.3.61
    Uninstalling nvidia-cufft-cu12-11.2.3.61:
      Successfully uninstalled nvidia-cufft-cu12-11.2.3.61
  Attempting uninstall: nvidia-cuda-runtime-cu12
    Found existing installation: nvidia-cuda-runtime-cu12 12.5.82
    Uninstalling nvidia-cuda-runtime-cu12-12.5.82:
      Successfully uninstalled nvidia-cuda-runtime-cu12-12.5.82
  Attempting uninstall: nvidia-cuda-nvrtc-cu12
    Found existing installation: nvidia-cuda-nvrtc-cu12 12.5.82
    Uninstalling nvidia-cuda-nvrtc-cu12-12.5.82:
      Successfully uninstalled nvidia-cuda-nvrtc-cu12-12.5.82
```

```
import cv2
import matplotlib.pyplot as plt
from PIL import Image
import numpy as np
import os
```

Task 4: AI-Based Image Upscaling

Objective: Implement AI-based image upscaling to enlarge an image by 4x while maintaining the highest clarity.

```
!pip install torchvision==0.16.1
```

```
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 124.2/124.2 MB 7.6 MB/s eta 0:00:00
Downloading nvidia_cusparse_cu12-12.1.0.106-py3-none-manylinux1_x86_64.whl (196.0 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 196.0/196.0 MB 6.8 MB/s eta 0:00:00
Downloading nvidia_nccl_cu12-2.18.1-py3-none-manylinux1_x86_64.whl (209.8 MB)
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Downloading nvidia_nvtx_cu12-12.1.105-py3-none-manylinux1_x86_64.whl (99 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 99.1/99.1 kB 8.7 MB/s eta 0:00:00
Downloading triton-2.1.0-0-cp311-cp311-manylinux2014_x86_64.manylinux_2_17_x86_64.whl (89.2 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 89.2/89.2 MB 8.2 MB/s eta 0:00:00
Installing collected packages: triton, nvidia-nvtx-cu12, nvidia-nccl-cu12, nvidia-cusparse-cu12, nvidia-curand-cu12, nvidia-cufft-
  Attempting uninstall: triton
    Found existing installation: triton 3.2.0
    Uninstalling triton-3.2.0:
      Successfully uninstalled triton-3.2.0
  Attempting uninstall: nvidia-nvtx-cu12
    Found existing installation: nvidia-nvtx-cu12 12.4.127
    Uninstalling nvidia-nvtx-cu12-12.4.127:
      Successfully uninstalled nvidia-nvtx-cu12-12.4.127
  Attempting uninstall: nvidia-nccl-cu12
    Found existing installation: nvidia-nccl-cu12 2.21.5
    Uninstalling nvidia-nccl-cu12-2.21.5:
      Successfully uninstalled nvidia-nccl-cu12-2.21.5
  Attempting uninstall: nvidia-cusparse-cu12
    Found existing installation: nvidia-cusparse-cu12 12.3.1.170
    Uninstalling nvidia-cusparse-cu12-12.3.1.170:
      Successfully uninstalled nvidia-cusparse-cu12-12.3.1.170
  Attempting uninstall: nvidia-curand-cu12
    Found existing installation: nvidia-curand-cu12 10.3.5.147
    Uninstalling nvidia-curand-cu12-10.3.5.147:
      Successfully uninstalled nvidia-curand-cu12-10.3.5.147
  Attempting uninstall: nvidia-cufft-cu12
    Found existing installation: nvidia-cufft-cu12 11.2.1.3
    Uninstalling nvidia-cufft-cu12-11.2.1.3:
      Successfully uninstalled nvidia-cufft-cu12-11.2.1.3
  Attempting uninstall: nvidia-cuda-runtime-cu12
    Found existing installation: nvidia-cuda-runtime-cu12 12.4.127
    Uninstalling nvidia-cuda-runtime-cu12-12.4.127:
      Successfully uninstalled nvidia-cuda-runtime-cu12-12.4.127
  Attempting uninstall: nvidia-cuda-nvrtc-cu12
    Found existing installation: nvidia-cuda-nvrtc-cu12 12.4.127
    Uninstalling nvidia-cuda-nvrtc-cu12-12.4.127:
      Successfully uninstalled nvidia-cuda-nvrtc-cu12-12.4.127
  Attempting uninstall: nvidia-cuda-cupti-cu12
    Found existing installation: nvidia-cuda-cupti-cu12 12.4.127
    Uninstalling nvidia-cuda-cupti-cu12-12.4.127:
      Successfully uninstalled nvidia-cuda-cupti-cu12-12.4.127
  Attempting uninstall: nvidia-cublas-cu12
    Found existing installation: nvidia-cublas-cu12 12.4.5.8
    Uninstalling nvidia-cublas-cu12-12.4.5.8:
      Successfully uninstalled nvidia-cublas-cu12-12.4.5.8
  Attempting uninstall: nvidia-cusolver-cu12
    Found existing installation: nvidia-cusolver-cu12 11.6.1.9
    Uninstalling nvidia-cusolver-cu12-11.6.1.9:
      Successfully uninstalled nvidia-cusolver-cu12-11.6.1.9
```

```
!pip install numpy==1.24.4
```

```
Collecting numpy==1.24.4
  Downloading numpy-1.24.4-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (5.6 kB)
Downloading numpy-1.24.4-cp311-cp311-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (17.3 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 17.3/17.3 MB 82.1 MB/s eta 0:00:00
Installing collected packages: numpy
  Attempting uninstall: numpy
    Found existing installation: numpy 2.0.2
    Uninstalling numpy-2.0.2:
      Successfully uninstalled numpy-2.0.2
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the sou
pymc 5.21.2 requires numpy>=1.25.0, but you have numpy 1.24.4 which is incompatible.
tensorflow 2.18.0 requires numpy<2.1.0,>=1.26.0, but you have numpy 1.24.4 which is incompatible.
treescope 0.1.9 requires numpy>=1.25.2, but you have numpy 1.24.4 which is incompatible.
jax 0.5.2 requires numpy>=1.25, but you have numpy 1.24.4 which is incompatible.
blosc2 3.3.0 requires numpy>=1.26, but you have numpy 1.24.4 which is incompatible.
thinc 8.3.6 requires numpy<3.0.0,>=2.0.0, but you have numpy 1.24.4 which is incompatible.
jaxlib 0.5.1 requires numpy>=1.25, but you have numpy 1.24.4 which is incompatible.
Successfully installed numpy-1.24.4
WARNING: The following packages were previously imported in this runtime:
  [numpy]
You must restart the runtime in order to use newly installed versions.
```

RESTART SESSION

Traditional Upscaling (Nearest + Bicubic)

```
def upscale_traditional(img_path, scale=4):
    img = cv2.imread(img_path)
    h, w = img.shape[:2]
    new_size = (w * scale, h * scale)

    nearest = cv2.resize(img, new_size, interpolation=cv2.INTER_NEAREST)
    bicubic = cv2.resize(img, new_size, interpolation=cv2.INTER_CUBIC)

    cv2.imwrite("nearest_x4.jpg", nearest)
    cv2.imwrite("bicubic_x4.jpg", bicubic)
    print("[✓] Saved Nearest and Bicubic Upscaled Images.")
    return nearest, bicubic
```

Real-ESRGAN Upscaling

```
def upscale_real_esrgan(img_path):
    from realesrgan import RealESRGAN


    # Load the image
    img = Image.open(img_path).convert("RGB")

    # Load ESRGAN model
    model = RealESRGAN.from_pretrained('RealESRGAN_x4plus')  # 4x upscale model
    model.eval()

    # Upscale
    with torch.no_grad():
        sr_img = model(img)

    sr_img.save("real_esrgan_x4.jpg")
    print("[✓] Saved Real-ESRGAN Upscaled Image.")
    return sr_img
```

Comparison Result

```
def show_comparison(images, titles):
    plt.figure(figsize=(15, 5))
    for i, (img, title) in enumerate(zip(images, titles)):
        plt.subplot(1, len(images), i+1)
        if isinstance(img, np.ndarray):
            img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
            plt.imshow(img)
        else:
            plt.imshow(img)
        plt.title(title)
        plt.axis('off')
    plt.tight_layout()
    plt.show()
```

```
import cv2
from PIL import Image
import matplotlib.pyplot as plt
import numpy as np

image_path = '/content/task4_img.jpg'  # Replace with your full path if needed

nearest_img, bicubic_img = upscale_traditional(image_path)
try:
    import torch
    sr_img = upscale_real_esrgan(image_path)
except Exception as e:
    sr_img = None
    print("Real-ESRGAN failed:", e)

# Show all results
images = [cv2.imread(image_path), nearest_img, bicubic_img]
titles = ['Original', 'Nearest', 'Bicubic']

if sr_img:
    images.append(sr_img)
    titles.append('Real-ESRGAN')

show_comparison(images, titles)
```

```
[✓] Saved Nearest and Bicubic Upscaled Images.
/usr/local/lib/python3.11/dist-packages/torchvision/transforms/functional_tensor.py:5: UserWarning: The torchvision.transforms.funct
  warnings.warn(
✗ Real-ESRGAN failed: cannot import name 'RealESRGAN' from 'realesrgan' (/usr/local/lib/python3.11/dist-packages/realesrgan/__init
```


```
#  Real-ESRGAN Super Resolution
# Step 1: Clone the repo and install dependencies
!git clone https://github.com/xinntao/Real-ESRGAN.git
%cd Real-ESRGAN
!pip install -r requirements.txt
!python setup.py develop

# Step 2: Download Pre-trained Model
!wget https://github.com/xinntao/Real-ESRGAN/releases/download/v0.1.0/RealESRGAN_x4plus.pth -P weights
```

```
Best match: future 1.0.0
```

```
Adding future 1.0.0 to easy-install.pth file
Installing futurize script to /usr/local/bin
Installing pasteurize script to /usr/local/bin

Using /usr/local/lib/python3.11/dist-packages
Searching for addict==2.4.0
Best match: addict 2.4.0
Adding addict 2.4.0 to easy-install.pth file

Using /usr/local/lib/python3.11/dist-packages
Searching for certifi==2025.1.31
Best match: certifi 2025.1.31
Adding certifi 2025.1.31 to easy-install.pth file

Using /usr/local/lib/python3.11/dist-packages
```

```
# Step 3: Upload your image
from google.colab import files
uploaded = files.upload()

# Step 4: Run Super Resolution
!python inference_realesrgan.py -n RealESRGAN_x4plus -i task4_img.jpg --outscale 4 --fp32
```

```
Choose Files task4_img.jpg
• task4_img.jpg(image/jpeg) - 2138 bytes, last modified: 4/10/2025 - 100% done
Saving task4_img.jpg to task4_img.jpg
/usr/local/lib/python3.11/dist-packages/torchvision/transforms/functional_tensor.py:5: UserWarning: The torchvision.transforms.funct
  warnings.warn(
Testing 0 task4_img
```

```
import cv2
from PIL import Image
import matplotlib.pyplot as plt

# Load images
original = cv2.imread("/content/task4_img.jpg")
nearest = cv2.imread("/content/nearest_x4.jpg")
bicubic = cv2.imread("/content/bicubic_x4.jpg")
esrgan = Image.open("/content/Real-ESRGAN/results/task4_img_out.jpg")

# Convert BGR to RGB
original = cv2.cvtColor(original, cv2.COLOR_BGR2RGB)
nearest = cv2.cvtColor(nearest, cv2.COLOR_BGR2RGB)
bicubic = cv2.cvtColor(bicubic, cv2.COLOR_BGR2RGB)

# Plot
titles = ["Original", "Nearest x4", "Bicubic x4", "Real-ESRGAN x4"]
images = [original, nearest, bicubic, esrgan]

plt.figure(figsize=(20, 10))
for i, (img, title) in enumerate(zip(images, titles)):
    plt.subplot(1, 4, i+1)
    plt.imshow(img)
    plt.title(title)
    plt.axis('off')

plt.tight_layout()
plt.show()
```

Start coding or generate with AI.