HW0

September 11, 2025

1 HW0 - Turn your favorite photo a rotating video

Total Points: 100

Assignment Due: Sep 11th Thursday 11:59 PM EST

In this assignment, you will: - Implement rotation using **forward mapping** (origin & arbitrary center) - Implement rotation using **inverse mapping** (origin & arbitrary center) - Animate your image rotating and export as an MP4 video

Please submit the following files on Canvas: - The original .ipynb notebook - A PDF version of the .ipynb notebook - rotation.mp4 - rotating_favorite_video.mp4 - rotating_favorite_creative_video.mp4

Allowed libraries: **numpy, matplotlib (plt), imageio, opencv-python (cv2)**

```
[1]: !pip install numpy matplotlib imageio opencv-python
```

```
Requirement already satisfied: numpy in /usr/local/lib/python3.12/dist-packages
(2.0.2)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.12/dist-
packages (3.10.0)
Requirement already satisfied: imageio in /usr/local/lib/python3.12/dist-
packages (2.37.0)
Requirement already satisfied: opencv-python in /usr/local/lib/python3.12/dist-
packages (4.12.0.88)
Requirement already satisfied: contourpy>=1.0.1 in
/usr/local/lib/python3.12/dist-packages (from matplotlib) (1.3.3)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.12/dist-
packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
/usr/local/lib/python3.12/dist-packages (from matplotlib) (4.59.2)
Requirement already satisfied: kiwisolver>=1.3.1 in
/usr/local/lib/python3.12/dist-packages (from matplotlib) (1.4.9)
Requirement already satisfied: packaging>=20.0 in
/usr/local/lib/python3.12/dist-packages (from matplotlib) (25.0)
Requirement already satisfied: pillow>=8 in /usr/local/lib/python3.12/dist-
packages (from matplotlib) (11.3.0)
Requirement already satisfied: pyparsing>=2.3.1 in
/usr/local/lib/python3.12/dist-packages (from matplotlib) (3.2.3)
```

Requirement already satisfied: python-dateutil>=2.7 in
/usr/local/lib/python3.12/dist-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-
packages (from python-dateutil>=2.7->matplotlib) (1.17.0)

Use `imageio.imread` to load the sample image.

```python
import imageio
import matplotlib.pyplot as plt

img = imageio.imread('Lenna.png')
plt.imshow(img)
plt.axis('off')
plt.show()
```

/tmp/ipython-input-3604052135.py:4: DeprecationWarning: Starting with ImageIO v3
the behavior of this function will switch to that of iio.v3.imread. To keep the
current behavior (and make this warning disappear) use `import imageio.v2 as
imageio` or call `imageio.v2.imread` directly.
  img = imageio.imread('Lenna.png')

1.1 Part A. Forward Mapping (30 points)

1.1.1 Explanation

- **Equation:**

$$x_d = R(\theta)\, x_s$$

where

$$R(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

- **Insight:** *Where will the pixel land in the destination? (Throwing pixels forward).*

- **Pseudocode:**

```
for each pixel (x_s, y_s) in source:
    [x_d, y_d] = R(theta) * [x_s, y_s]
    put source(x_s, y_s) into destination(round(x_d), round(y_d))
```

1.1.2 Q1-1. Implement `forward_mapping_origin` (15 points)

Write a function that rotates around the origin using forward mapping.

```
[3]:  # Some stuff that is commented out was very slow during video
      # generation, switched to vectorized operations on all tasks
      # for faster execution
```

```
[4]:  # import numpy as np

      # def forward_mapping_origin(img, theta_deg):
      #     # TODO: Implement forward mapping around origin
      #     theta_rad = np.deg2rad(theta_deg)
      #     src_h, src_w = img.shape[:2]
      #     dst_h = src_h
      #     dst_w = src_w

      #     out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

      #     # YOUR CODE HERE
      #     for c in range(img.shape[2]):
      #       for x_s in range(src_w):
      #             for y_s in range(src_h):
      #                 cur = np.array([x_s, y_s])
      #                 R = np.array([[np.cos(theta_rad), -np.sin(theta_rad)],
      #                               [np.sin(theta_rad), np.cos(theta_rad)]])

      #                 dest = (R @ cur).astype(int)
      #                 x_d, y_d = dest[0], dest[1]

      #                 if 0 <= x_d < dst_w and 0 <= y_d < dst_h:
```

```
#                    out[y_d, x_d, c] = img[y_s, x_s, c]

#        return out
```

```python
import numpy as np

def forward_mapping_origin(img, theta_deg):
    # TODO: Implement forward mapping around origin
    theta_rad = np.deg2rad(theta_deg)
    src_h, src_w = img.shape[:2]
    dst_h = src_h
    dst_w = src_w

    out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

    # YOUR CODE HERE
    R = np.array([[np.cos(theta_rad), -np.sin(theta_rad)],
                  [np.sin(theta_rad),  np.cos(theta_rad)]])

    ys, xs = np.indices((src_h, src_w))
    coords = np.stack([xs.ravel(), ys.ravel()], axis=-1)  # shape (N, 2)

    # vectorized rotate
    dest = (coords @ R.T).round().astype(int)
    xd, yd = dest[:, 0], dest[:, 1]



    mask = (0 <= xd) & (xd < dst_w) & (0 <= yd) & (yd < dst_h)
    out[yd[mask], xd[mask]] = img[coords[mask, 1], coords[mask, 0]]

    return out
```

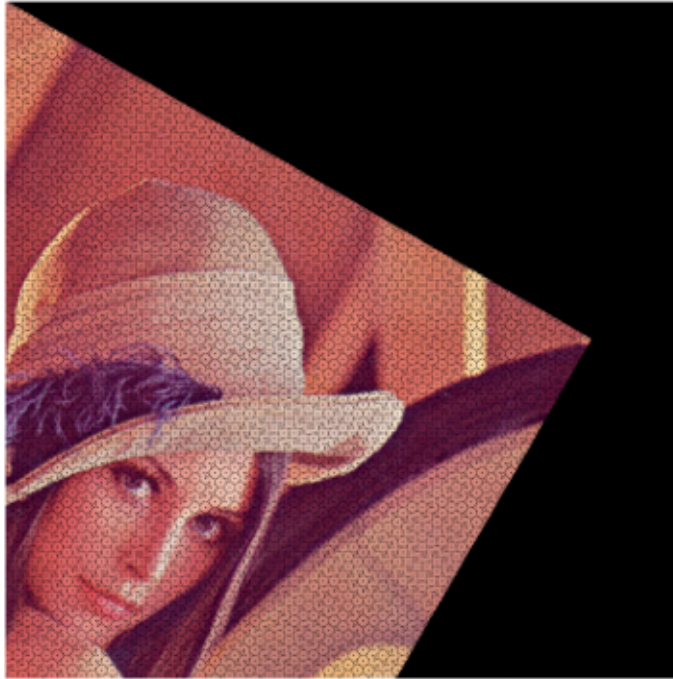### 1.1.3 Q1-2. Rotate by 30 degrees and display (5 points)

The image should look like it is rotated by -30 degree because in a Numpy array, the y-axis increases downward, whereas in Cartesian coordinates, the y-axis increases upward.

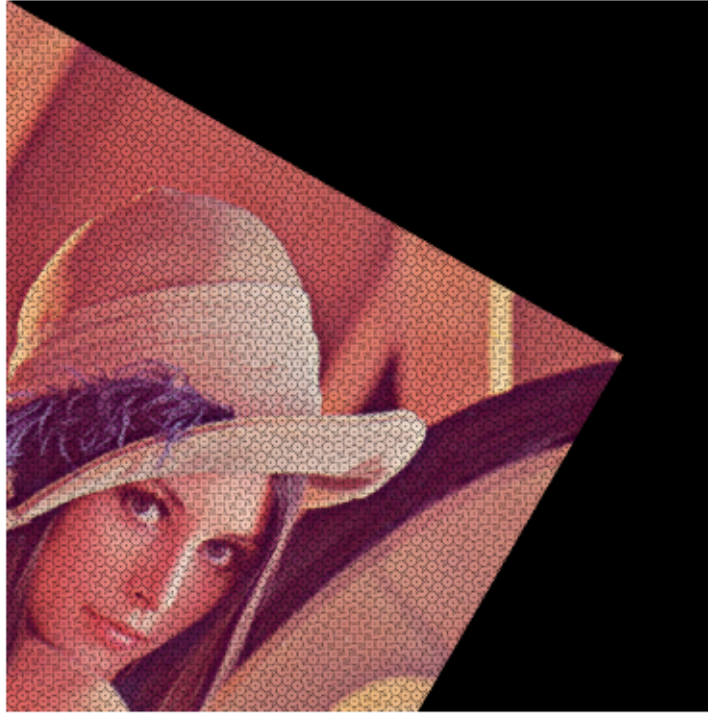The expected output looks as follows:

```python
expected_output = imageio.imread('HW0_Q1_2_expected_output.png')
plt.imshow(expected_output)
plt.axis('off')
plt.show()
```

/tmp/ipython-input-188146722.py:1: DeprecationWarning: Starting with ImageIO v3 the behavior of this function will switch to that of iio.v3.imread. To keep the current behavior (and make this warning disappear) use `import imageio.v2 as imageio` or call `imageio.v2.imread` directly.

```
expected_output = imageio.imread('HW0_Q1_2_expected_output.png')
```



```
[7]:  # Plot the output here.
      rotated = forward_mapping_origin(img, 30)
      plt.imshow(rotated)
      plt.axis('off')
      plt.show()
```

1.1.4 Q1-3. Implement rotation around arbitrary coordinate (15 points)

Hint: shift coordinates so that the chosen point is treated as the origin before rotation.

```python
[8]:  # def forward_mapping_arbitrary(img, theta_deg, cx, cy):
      #     # TODO: Implement forward mapping around arbitrary point (cx, cy)
      #     theta_rad = np.deg2rad(theta_deg)
      #     src_h, src_w = img.shape[:2]
      #     dst_h = src_h
      #     dst_w = src_w


      #     out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

      #     # YOUR CODE HERE
      #     for c in range(img.shape[2]):
      #       for x_s in range(src_w):
      #           for y_s in range(src_h):
      #             cur = np.array([x_s, y_s])
      #            R = np.array([[np.cos(theta_rad), -np.sin(theta_rad)],
      #                          [np.sin(theta_rad), np.cos(theta_rad)]])
```

```
#                dest = (R @ (cur - np.array([cx, cy])) + np.array([cx, cy])).
 astype(int)
#                x_d, y_d = dest[0], dest[1]

#                if 0 <= x_d < dst_w and 0 <= y_d < dst_h:
#                    out[y_d, x_d, c] = img[y_s, x_s, c]

#        return out
```

```python
[9]: import numpy as np

def forward_mapping_arbitrary(img, theta_deg, cx, cy):
    # TODO: Implement forward mapping around arbitrary point (cx, cy)
    theta_rad = np.deg2rad(theta_deg)
    src_h, src_w = img.shape[:2]
    dst_h = src_h
    dst_w = src_w

    out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

    # YOUR CODE HERE
    R = np.array([[np.cos(theta_rad), -np.sin(theta_rad)],
                  [np.sin(theta_rad),  np.cos(theta_rad)]])

    ys, xs = np.indices((src_h, src_w))
    coords = np.stack([xs.ravel(), ys.ravel()], axis=-1)   # shape (N, 2)

    # vectorized rotate around (cx, cy)
    dest = ((coords - np.array([cx, cy])) @ R.T + np.array([cx, cy])).round().
 astype(int)
    xd, yd = dest[:, 0], dest[:, 1]

    mask = (0 <= xd) & (xd < dst_w) & (0 <= yd) & (yd < dst_h)
    out[yd[mask], xd[mask]] = img[coords[mask, 1], coords[mask, 0]]

    return out
```

1.1.5 Q1-4. Rotate with center (x=256, y=256), =30° and display (5 points)

The expected output looks as follows:

```python
[10]: expected_output = imageio.imread('HW0_Q1_4_expected_output.png')
plt.imshow(expected_output)
plt.axis('off')
plt.show()
```

```
[11]:  # Plot the output here.
       rotated = forward_mapping_arbitrary(img, 30, 256, 256)
       plt.imshow(rotated)
       plt.axis('off')
       plt.show()
```

Problems with forward mapping: holes (gap in the image) - they appear because some destination pixels are not assigned a value when multiple source pixels map to the same location or when no source pixel maps to a destination pixel. That is why we use **inverse mapping**.

1.2 Part B. Inverse Mapping (30 points)

1.2.1 Explanation

- **Equation:**

$$x_s = R(-\theta)\, x_d$$

where

$$R(-\theta) = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

- **Insight:** *Walk over each destination pixel and ask: where should I pull the color from in the source?*

- **Pseudocode:**

```
for each pixel (x_d, y_d) in destination:
    [x_s, y_s] = R(-theta) * [x_d, y_d]
    destination(x_d, y_d) = sample_from_source(x_s, y_s)
```

1.2.2   Q2-1. Implement `inverse_mapping_origin` (15 points)

```
[12]: # def inverse_mapping_origin(img, theta_deg):
      #     # TODO: Implement inverse mapping rotation around origin
      #     theta_rad = np.deg2rad(theta_deg)
      #     src_h, src_w = img.shape[:2]
      #     dst_h = src_h
      #     dst_w = src_w

      #     out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

      #     # YOUR CODE HERE
      #     for c in range(img.shape[2]):
      #       for x_d in range(dst_w):
      #           for y_d in range(dst_h):
      #               cur = np.array([x_d, y_d])
      #               R = np.array([[np.cos(theta_rad), np.sin(theta_rad)],
      #                             [-np.sin(theta_rad), np.cos(theta_rad)]])

      #               dest = (R @ cur).astype(int)
      #               x_s, y_s = dest[0], dest[1]

      #               if 0 <= x_s < src_w and 0 <= y_s < src_h:
      #                   out[y_d, x_d, c] = img[y_s, x_s, c]

      #     return out
```

```
[13]: import numpy as np

      def inverse_mapping_origin(img, theta_deg):
          # TODO: Implement inverse mapping rotation around origin
          theta_rad = np.deg2rad(theta_deg)
          src_h, src_w = img.shape[:2]
          dst_h = src_h
          dst_w = src_w

          out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

          # YOUR CODE HERE
          R = np.array([[np.cos(theta_rad), np.sin(theta_rad)],
                        [-np.sin(theta_rad), np.cos(theta_rad)]])

          ys, xs = np.indices((dst_h, dst_w))
          coords = np.stack([xs.ravel(), ys.ravel()], axis=-1)   # shape (N, 2)

          # vectorized inverse rotate
          dest = (coords @ R.T).round().astype(int)
```

```
        xs_s, ys_s = dest[:, 0], dest[:, 1]

        mask = (0 <= xs_s) & (xs_s < src_w) & (0 <= ys_s) & (ys_s < src_h)
        out[coords[mask, 1], coords[mask, 0]] = img[ys_s[mask], xs_s[mask]]

        return out
```

1.2.3   Q2-2. Display rotation (=30°) (5 points)

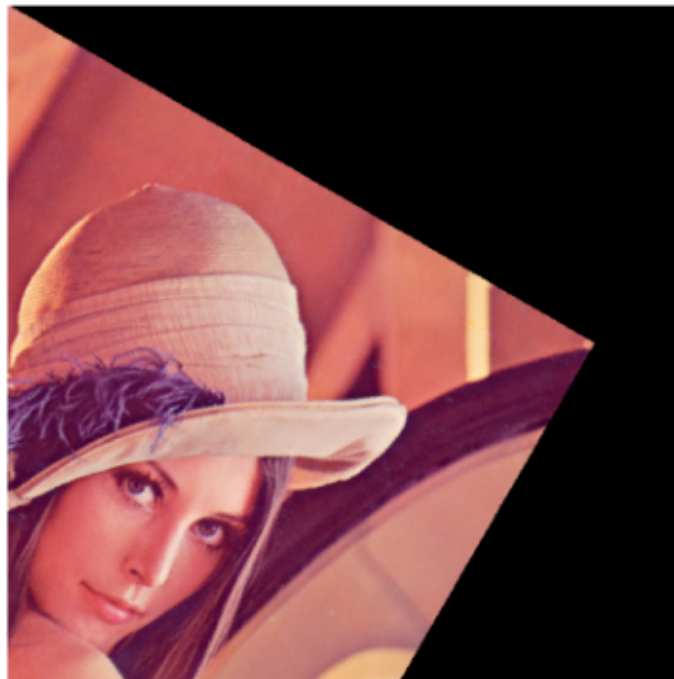The expected output looks as follows:

```
[14]: expected_output = imageio.imread('HW0_Q2_2_expected_output.png')
      plt.imshow(expected_output)
      plt.axis('off')
      plt.show()
```
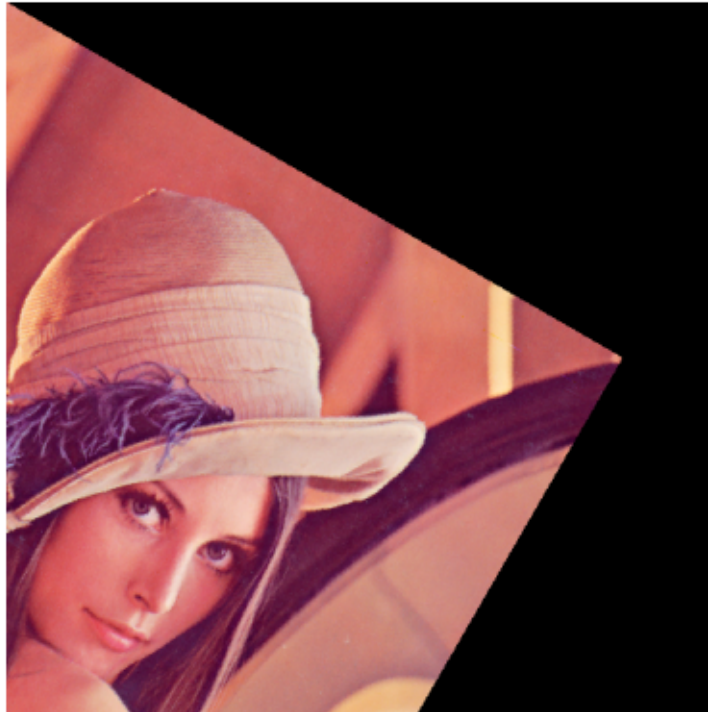
/tmp/ipython-input-4232865078.py:1: DeprecationWarning: Starting with ImageIO v3
the behavior of this function will switch to that of iio.v3.imread. To keep the
current behavior (and make this warning disappear) use `import imageio.v2 as
imageio` or call `imageio.v2.imread` directly.
  expected_output = imageio.imread('HW0_Q2_2_expected_output.png')

```
[15]:  # Plot the output here.
       rotated = inverse_mapping_origin(img, 30)
       plt.imshow(rotated)
       plt.axis('off')
       plt.show()
```


1.2.4 Q2-3. Implement rotation around arbitrary center (15 points)

```
[16]:  # def inverse_mapping_arbitrary(img, theta_deg, cx, cy):
       #     # TODO: Implement inverse mapping around arbitrary point (cx, cy)
       #     theta_rad = np.deg2rad(theta_deg)
       #     src_h, src_w = img.shape[:2]
       #     dst_h = src_h
       #     dst_w = src_w

       #     out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

       #     # YOUR CODE HERE
       #     for c in range(img.shape[2]):
       #       for x_d in range(dst_w):
       #           for y_d in range(dst_h):
       #               cur = np.array([x_d, y_d])
       #               R = np.array([[np.cos(theta_rad), np.sin(theta_rad)],
```

```
#                              [-np.sin(theta_rad), np.cos(theta_rad)]])

#          dest = (R @ (cur - np.array([cx, cy])) + np.array([cx, cy])).
  ↪astype(int)
#          x_s, y_s = dest[0], dest[1]

#          if 0 <= x_s < src_w and 0 <= y_s < src_h:
#              out[y_d, x_d, c] = img[y_s, x_s, c]

#      return out
```

```
[17]: import numpy as np

      def inverse_mapping_arbitrary(img, theta_deg, cx, cy):
          # TODO: Implement inverse mapping around arbitrary point (cx, cy)
          theta_rad = np.deg2rad(theta_deg)
          src_h, src_w = img.shape[:2]
          dst_h = src_h
          dst_w = src_w

          out = np.zeros((dst_h, dst_w,3),dtype=np.uint8)

          # YOUR CODE HERE
          R = np.array([[np.cos(theta_rad), np.sin(theta_rad)],
                        [-np.sin(theta_rad), np.cos(theta_rad)]])

          ys, xs = np.indices((dst_h, dst_w))
          coords = np.stack([xs.ravel(), ys.ravel()], axis=-1)   # shape (N, 2)

          # vectorized inverse rotate around (cx, cy)
          dest = ((coords - np.array([cx, cy])) @ R.T + np.array([cx, cy])).round().
      ↪astype(int)
          xs_s, ys_s = dest[:, 0], dest[:, 1]

          mask = (0 <= xs_s) & (xs_s < src_w) & (0 <= ys_s) & (ys_s < src_h)
          out[coords[mask, 1], coords[mask, 0]] = img[ys_s[mask], xs_s[mask]]

          return out
```

1.2.5   Q2-4. Display result (x=256, y=256, =30°) (5 points)

The expected output looks as follows:

```
[18]: expected_output = imageio.imread('HW0_Q2_4_expected_output.png')
      plt.imshow(expected_output)
      plt.axis('off')
      plt.show()
```

```
/tmp/ipython-input-431391595.py:1: DeprecationWarning: Starting with ImageIO v3
the behavior of this function will switch to that of iio.v3.imread. To keep the
current behavior (and make this warning disappear) use `import imageio.v2 as
imageio` or call `imageio.v2.imread` directly.
  expected_output = imageio.imread('HW0_Q2_4_expected_output.png')
```



```python
[19]:  # Plot the output here
       rotated = inverse_mapping_arbitrary(img, 30, 256, 256)
       plt.imshow(rotated)
       plt.axis('off')
       plt.show()
```

1.3 Part C. Animation (40 points)

1.3.1 Q3-1. Rotation animation (15 points)

Implement a function to rotate the image continuously around the center and save as an MP4.

```python
[20]: import cv2

def make_rotation_video(img, seconds=3, fps=24, out_file='rotation.mp4'):
    h, w = img.shape[:2]
    center = (w//2, h//2)
    fourcc = cv2.VideoWriter_fourcc(*'mp4v')
    writer = cv2.VideoWriter(out_file, fourcc, fps, (w, h))

    # YOUR CODE HERE
    N = fps * seconds

    for t in range(N):

        theta = 360 * t / N

        frame = inverse_mapping_arbitrary(img, theta, *center)
        frame_bgr = cv2.cvtColor(frame, cv2.COLOR_RGB2BGR)
        writer.write(frame_bgr)
```

```
        writer.release()


make_rotation_video(img, seconds=3, fps=24)
```

1.3.2 Q3-2. Turn Your Favorite Photo a Rotatinv Video (10 points)

```
[21]: # Load your own favorite photo
      favorite_photo = imageio.imread('f40_wheel.jpg')
      make_rotation_video(favorite_photo, seconds=3, fps=24,␣
       ↪out_file='rotating_favorite_photo.mp4')
```

```
/tmp/ipython-input-2606092892.py:2: DeprecationWarning: Starting with ImageIO v3
the behavior of this function will switch to that of iio.v3.imread. To keep the
current behavior (and make this warning disappear) use `import imageio.v2 as
imageio` or call `imageio.v2.imread` directly.
  favorite_photo = imageio.imread('f40_wheel.jpg')
```

1.3.3 Q3-3. Creative Animation (15 points)

Create your own fun animation ('rotating_favorite_photo_creative.mp4'). For example: - Image
flying out of frame - Zoom in/out while rotating - Add trails or effects Be creative!

```
[22]: import numpy as np

      def spiral_inverse_mapping_arbitrary(img, theta_deg, cx, cy, spiral_factor=0.
       ↪05):
          theta_rad_base = np.deg2rad(theta_deg)
          src_h, src_w = img.shape[:2]
          dst_h = src_h
          dst_w = src_w

          out = np.zeros((dst_h, dst_w,3), dtype=np.uint8)

          ys, xs = np.indices((dst_h, dst_w))
          coords = np.stack([xs.ravel(), ys.ravel()], axis=-1)  # shape (N, 2)

          # spiral angle setup based on radius
          dists = np.linalg.norm(coords - np.array([cx, cy]), axis=1)
          thetas = theta_rad_base + spiral_factor * dists

          # compute rotation for each pixel
          cos_t = np.cos(thetas)
          sin_t = np.sin(thetas)

          # vectorized rotation
          dx = coords[:, 0] - cx
```

```
        dy = coords[:, 1] - cy

        xs_s = (cos_t * dx + sin_t * dy + cx).round().astype(int)
        ys_s = (-sin_t * dx + cos_t * dy + cy).round().astype(int)

        mask = (0 <= xs_s) & (xs_s < src_w) & (0 <= ys_s) & (ys_s < src_h)
        out[coords[mask, 1], coords[mask, 0]] = img[ys_s[mask], xs_s[mask]]

        return out
```

[23]:
```python
import cv2

def make_rotation_spiral_video(img, seconds=3, fps=24,
                               spiral_factor=0.05,␣
  ↪out_file='rotating_favorite_photo_creative.mp4'):

    h, w = img.shape[:2]
    center = (w//2, h//2)
    fourcc = cv2.VideoWriter_fourcc(*'mp4v')
    writer = cv2.VideoWriter(out_file, fourcc, fps, (w, h))

    # YOUR CODE HERE
    N = fps * seconds

    for t in range(N):

        theta = 360 * t / N

        frame = spiral_inverse_mapping_arbitrary(img, theta, *center,
                                        spiral_factor=spiral_factor *␣
  ↪t / (2*N))
        frame_bgr = cv2.cvtColor(frame, cv2.COLOR_RGB2BGR)
        writer.write(frame_bgr)
    writer.release()

make_rotation_spiral_video(img, seconds=3, fps=24)
```

[39]:
```
!apt-get update -qq
!apt-get install -y texlive-xetex texlive-fonts-recommended␣
  ↪texlive-plain-generic pandoc
!apt-get install -y pandoc
!pip install nbconvert
```

W: Skipping acquire of configured file 'main/source/Sources' as repository
'https://r2u.stat.illinois.edu/ubuntu jammy InRelease' does not seem to provide
it (sources.list entry misspelt?)

```
Reading package lists… Done
Building dependency tree… Done
Reading state information… Done
pandoc is already the newest version (2.9.2.1-3ubuntu2).
The following additional packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 libapache-pom-java libcommons-logging-java
  libcommons-parent-java libfontbox-java libgs9 libgs9-common libidn12
  libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1 libruby3.0
  libsynctex2 libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13
  lmodern poppler-data preview-latex-style rake ruby ruby-net-telnet
  ruby-rubygems ruby-webrick ruby-xmlrpc ruby3.0 rubygems-integration t1utils
  teckit tex-common tex-gyre texlive-base texlive-binaries texlive-latex-base
  texlive-latex-extra texlive-latex-recommended texlive-pictures tipa
  xfonts-encodings xfonts-utils
Suggested packages:
  fonts-noto fonts-freefont-otf | fonts-freefont-ttf libavalon-framework-java
  libcommons-logging-java-doc libexcalibur-logkit-java liblog4j1.2-java
  poppler-utils ghostscript fonts-japanese-mincho | fonts-ipafont-mincho
  fonts-japanese-gothic | fonts-ipafont-gothic fonts-arphic-ukai
  fonts-arphic-uming fonts-nanum ri ruby-dev bundler debhelper gv
  | postscript-viewer perl-tk xpdf | pdf-viewer xzdec
  texlive-fonts-recommended-doc texlive-latex-base-doc python3-pygments
  icc-profiles libfile-which-perl libspreadsheet-parseexcel-perl
  texlive-latex-extra-doc texlive-latex-recommended-doc texlive-luatex
  texlive-pstricks dot2tex prerex texlive-pictures-doc vprerex
  default-jre-headless tipa-doc
The following NEW packages will be installed:
  dvisvgm fonts-droid-fallback fonts-lato fonts-lmodern fonts-noto-mono
  fonts-texgyre fonts-urw-base35 libapache-pom-java libcommons-logging-java
  libcommons-parent-java libfontbox-java libgs9 libgs9-common libidn12
  libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1 libruby3.0
  libsynctex2 libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13
  lmodern poppler-data preview-latex-style rake ruby ruby-net-telnet
  ruby-rubygems ruby-webrick ruby-xmlrpc ruby3.0 rubygems-integration t1utils
  teckit tex-common tex-gyre texlive-base texlive-binaries
  texlive-fonts-recommended texlive-latex-base texlive-latex-extra
  texlive-latex-recommended texlive-pictures texlive-plain-generic
  texlive-xetex tipa xfonts-encodings xfonts-utils
0 upgraded, 53 newly installed, 0 to remove and 45 not upgraded.
Need to get 182 MB of archives.
After this operation, 571 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-droid-fallback all
1:6.0.1r16-1.1build1 [1,805 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-lato all 2.0-2.1
[2,696 kB]
Get:3 http://archive.ubuntu.com/ubuntu jammy/main amd64 poppler-data all
0.4.11-1 [2,171 kB]
```

```
Get:4 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-common all 6.17
[33.7 kB]
Get:5 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-urw-base35 all
20200910-1 [6,367 kB]
Get:6 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgs9-common
all 9.55.0~dfsg1-0ubuntu5.12 [753 kB]
Get:7 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libidn12 amd64
1.38-4ubuntu1 [60.0 kB]
Get:8 http://archive.ubuntu.com/ubuntu jammy/main amd64 libijs-0.35 amd64
0.35-15build2 [16.5 kB]
Get:9 http://archive.ubuntu.com/ubuntu jammy/main amd64 libjbig2dec0 amd64
0.19-3build2 [64.7 kB]
Get:10 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgs9 amd64
9.55.0~dfsg1-0ubuntu5.12 [5,031 kB]
Get:11 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libkpathsea6
amd64 2021.20210626.59705-1ubuntu0.2 [60.4 kB]
Get:12 http://archive.ubuntu.com/ubuntu jammy/main amd64 libwoff1 amd64
1.0.2-1build4 [45.2 kB]
Get:13 http://archive.ubuntu.com/ubuntu jammy/universe amd64 dvisvgm amd64
2.13.1-1 [1,221 kB]
Get:14 http://archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-lmodern all
2.004.5-6.1 [4,532 kB]
Get:15 http://archive.ubuntu.com/ubuntu jammy/main amd64 fonts-noto-mono all
20201225-1build1 [397 kB]
Get:16 http://archive.ubuntu.com/ubuntu jammy/universe amd64 fonts-texgyre all
20180621-3.1 [10.2 MB]
Get:17 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libapache-pom-java
all 18-1 [4,720 B]
Get:18 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libcommons-parent-
java all 43-1 [10.8 kB]
Get:19 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libcommons-logging-
java all 1.2-2 [60.3 kB]
Get:20 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libptexenc1
amd64 2021.20210626.59705-1ubuntu0.2 [39.1 kB]
Get:21 http://archive.ubuntu.com/ubuntu jammy/main amd64 rubygems-integration
all 1.18 [5,336 B]
Get:22 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby3.0 amd64
3.0.2-7ubuntu2.11 [50.1 kB]
Get:23 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby-rubygems
all 3.3.5-2ubuntu1.1 [228 kB]
Get:24 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby amd64 1:3.0~exp1
[5,100 B]
Get:25 http://archive.ubuntu.com/ubuntu jammy/main amd64 rake all 13.0.6-2 [61.7
kB]
Get:26 http://archive.ubuntu.com/ubuntu jammy/main amd64 ruby-net-telnet all
0.1.1-2 [12.6 kB]
Get:27 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby-webrick
all 1.7.0-3ubuntu0.2 [52.5 kB]
```

```
Get:28 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 ruby-xmlrpc all
0.3.2-1ubuntu0.1 [24.9 kB]
Get:29 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libruby3.0
amd64 3.0.2-7ubuntu2.11 [5,114 kB]
Get:30 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsynctex2
amd64 2021.20210626.59705-1ubuntu0.2 [55.6 kB]
Get:31 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libteckit0 amd64
2.5.11+ds1-1 [421 kB]
Get:32 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexlua53
amd64 2021.20210626.59705-1ubuntu0.2 [120 kB]
Get:33 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexluajit2
amd64 2021.20210626.59705-1ubuntu0.2 [267 kB]
Get:34 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libzzip-0-13 amd64
0.13.72+dfsg.1-1.1 [27.0 kB]
Get:35 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-encodings all
1:1.0.5-0ubuntu2 [578 kB]
Get:36 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-utils amd64
1:7.7+6build2 [94.6 kB]
Get:37 http://archive.ubuntu.com/ubuntu jammy/universe amd64 lmodern all
2.004.5-6.1 [9,471 kB]
Get:38 http://archive.ubuntu.com/ubuntu jammy/universe amd64 preview-latex-style
all 12.2-1ubuntu1 [185 kB]
Get:39 http://archive.ubuntu.com/ubuntu jammy/main amd64 t1utils amd64
1.41-4build2 [61.3 kB]
Get:40 http://archive.ubuntu.com/ubuntu jammy/universe amd64 teckit amd64
2.5.11+ds1-1 [699 kB]
Get:41 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-gyre all
20180621-3.1 [6,209 kB]
Get:42 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 texlive-
binaries amd64 2021.20210626.59705-1ubuntu0.2 [9,860 kB]
Get:43 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-base all
2021.20220204-1 [21.0 MB]
Get:44 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-fonts-
recommended all 2021.20220204-1 [4,972 kB]
Get:45 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-base
all 2021.20220204-1 [1,128 kB]
Get:46 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libfontbox-java all
1:1.8.16-2 [207 kB]
Get:47 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libpdfbox-java all
1:1.8.16-2 [5,199 kB]
Get:48 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-
recommended all 2021.20220204-1 [14.4 MB]
Get:49 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-pictures
all 2021.20220204-1 [8,720 kB]
Get:50 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-extra
all 2021.20220204-1 [13.9 MB]
Get:51 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-plain-
generic all 2021.20220204-1 [27.5 MB]
```

```
Get:52 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tipa all 2:1.3-21
[2,967 kB]
Get:53 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-xetex all
2021.20220204-1 [12.4 MB]
Fetched 182 MB in 6s (29.7 MB/s)
Extracting templates from packages: 100%
Preconfiguring packages …
Selecting previously unselected package fonts-droid-fallback.
(Reading database … 126599 files and directories currently installed.)
Preparing to unpack …/00-fonts-droid-fallback_1%3a6.0.1r16-1.1build1_all.deb
…
Unpacking fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Selecting previously unselected package fonts-lato.
Preparing to unpack …/01-fonts-lato_2.0-2.1_all.deb …
Unpacking fonts-lato (2.0-2.1) …
Selecting previously unselected package poppler-data.
Preparing to unpack …/02-poppler-data_0.4.11-1_all.deb …
Unpacking poppler-data (0.4.11-1) …
Selecting previously unselected package tex-common.
Preparing to unpack …/03-tex-common_6.17_all.deb …
Unpacking tex-common (6.17) …
Selecting previously unselected package fonts-urw-base35.
Preparing to unpack …/04-fonts-urw-base35_20200910-1_all.deb …
Unpacking fonts-urw-base35 (20200910-1) …
Selecting previously unselected package libgs9-common.
Preparing to unpack …/05-libgs9-common_9.55.0~dfsg1-0ubuntu5.12_all.deb …
Unpacking libgs9-common (9.55.0~dfsg1-0ubuntu5.12) …
Selecting previously unselected package libidn12:amd64.
Preparing to unpack …/06-libidn12_1.38-4ubuntu1_amd64.deb …
Unpacking libidn12:amd64 (1.38-4ubuntu1) …
Selecting previously unselected package libijs-0.35:amd64.
Preparing to unpack …/07-libijs-0.35_0.35-15build2_amd64.deb …
Unpacking libijs-0.35:amd64 (0.35-15build2) …
Selecting previously unselected package libjbig2dec0:amd64.
Preparing to unpack …/08-libjbig2dec0_0.19-3build2_amd64.deb …
Unpacking libjbig2dec0:amd64 (0.19-3build2) …
Selecting previously unselected package libgs9:amd64.
Preparing to unpack …/09-libgs9_9.55.0~dfsg1-0ubuntu5.12_amd64.deb …
Unpacking libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.12) …
Selecting previously unselected package libkpathsea6:amd64.
Preparing to unpack …/10-libkpathsea6_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libwoff1:amd64.
Preparing to unpack …/11-libwoff1_1.0.2-1build4_amd64.deb …
Unpacking libwoff1:amd64 (1.0.2-1build4) …
Selecting previously unselected package dvisvgm.
Preparing to unpack …/12-dvisvgm_2.13.1-1_amd64.deb …
```

```
Unpacking dvisvgm (2.13.1-1) …
Selecting previously unselected package fonts-lmodern.
Preparing to unpack …/13-fonts-lmodern_2.004.5-6.1_all.deb …
Unpacking fonts-lmodern (2.004.5-6.1) …
Selecting previously unselected package fonts-noto-mono.
Preparing to unpack …/14-fonts-noto-mono_20201225-1build1_all.deb …
Unpacking fonts-noto-mono (20201225-1build1) …
Selecting previously unselected package fonts-texgyre.
Preparing to unpack …/15-fonts-texgyre_20180621-3.1_all.deb …
Unpacking fonts-texgyre (20180621-3.1) …
Selecting previously unselected package libapache-pom-java.
Preparing to unpack …/16-libapache-pom-java_18-1_all.deb …
Unpacking libapache-pom-java (18-1) …
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack …/17-libcommons-parent-java_43-1_all.deb …
Unpacking libcommons-parent-java (43-1) …
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack …/18-libcommons-logging-java_1.2-2_all.deb …
Unpacking libcommons-logging-java (1.2-2) …
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack …/19-libptexenc1_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package rubygems-integration.
Preparing to unpack …/20-rubygems-integration_1.18_all.deb …
Unpacking rubygems-integration (1.18) …
Selecting previously unselected package ruby3.0.
Preparing to unpack …/21-ruby3.0_3.0.2-7ubuntu2.11_amd64.deb …
Unpacking ruby3.0 (3.0.2-7ubuntu2.11) …
Selecting previously unselected package ruby-rubygems.
Preparing to unpack …/22-ruby-rubygems_3.3.5-2ubuntu1.1_all.deb …
Unpacking ruby-rubygems (3.3.5-2ubuntu1.1) …
Selecting previously unselected package ruby.
Preparing to unpack …/23-ruby_1%3a3.0~exp1_amd64.deb …
Unpacking ruby (1:3.0~exp1) …
Selecting previously unselected package rake.
Preparing to unpack …/24-rake_13.0.6-2_all.deb …
Unpacking rake (13.0.6-2) …
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack …/25-ruby-net-telnet_0.1.1-2_all.deb …
Unpacking ruby-net-telnet (0.1.1-2) …
Selecting previously unselected package ruby-webrick.
Preparing to unpack …/26-ruby-webrick_1.7.0-3ubuntu0.2_all.deb …
Unpacking ruby-webrick (1.7.0-3ubuntu0.2) …
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack …/27-ruby-xmlrpc_0.3.2-1ubuntu0.1_all.deb …
Unpacking ruby-xmlrpc (0.3.2-1ubuntu0.1) …
Selecting previously unselected package libruby3.0:amd64.
```

```
Preparing to unpack …/28-libruby3.0_3.0.2-7ubuntu2.11_amd64.deb …
Unpacking libruby3.0:amd64 (3.0.2-7ubuntu2.11) …
Selecting previously unselected package libsynctex2:amd64.
Preparing to unpack …/29-libsynctex2_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack …/30-libteckit0_2.5.11+ds1-1_amd64.deb …
Unpacking libteckit0:amd64 (2.5.11+ds1-1) …
Selecting previously unselected package libtexlua53:amd64.
Preparing to unpack …/31-libtexlua53_2021.20210626.59705-1ubuntu0.2_amd64.deb
…
Unpacking libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libtexluajit2:amd64.
Preparing to unpack
…/32-libtexluajit2_2021.20210626.59705-1ubuntu0.2_amd64.deb …
Unpacking libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package libzzip-0-13:amd64.
Preparing to unpack …/33-libzzip-0-13_0.13.72+dfsg.1-1.1_amd64.deb …
Unpacking libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Selecting previously unselected package xfonts-encodings.
Preparing to unpack …/34-xfonts-encodings_1%3a1.0.5-0ubuntu2_all.deb …
Unpacking xfonts-encodings (1:1.0.5-0ubuntu2) …
Selecting previously unselected package xfonts-utils.
Preparing to unpack …/35-xfonts-utils_1%3a7.7+6build2_amd64.deb …
Unpacking xfonts-utils (1:7.7+6build2) …
Selecting previously unselected package lmodern.
Preparing to unpack …/36-lmodern_2.004.5-6.1_all.deb …
Unpacking lmodern (2.004.5-6.1) …
Selecting previously unselected package preview-latex-style.
Preparing to unpack …/37-preview-latex-style_12.2-1ubuntu1_all.deb …
Unpacking preview-latex-style (12.2-1ubuntu1) …
Selecting previously unselected package t1utils.
Preparing to unpack …/38-t1utils_1.41-4build2_amd64.deb …
Unpacking t1utils (1.41-4build2) …
Selecting previously unselected package teckit.
Preparing to unpack …/39-teckit_2.5.11+ds1-1_amd64.deb …
Unpacking teckit (2.5.11+ds1-1) …
Selecting previously unselected package tex-gyre.
Preparing to unpack …/40-tex-gyre_20180621-3.1_all.deb …
Unpacking tex-gyre (20180621-3.1) …
Selecting previously unselected package texlive-binaries.
Preparing to unpack …/41-texlive-
binaries_2021.20210626.59705-1ubuntu0.2_amd64.deb …
Unpacking texlive-binaries (2021.20210626.59705-1ubuntu0.2) …
Selecting previously unselected package texlive-base.
Preparing to unpack …/42-texlive-base_2021.20220204-1_all.deb …
Unpacking texlive-base (2021.20220204-1) …
```

```
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack …/43-texlive-fonts-recommended_2021.20220204-1_all.deb …
Unpacking texlive-fonts-recommended (2021.20220204-1) …
Selecting previously unselected package texlive-latex-base.
Preparing to unpack …/44-texlive-latex-base_2021.20220204-1_all.deb …
Unpacking texlive-latex-base (2021.20220204-1) …
Selecting previously unselected package libfontbox-java.
Preparing to unpack …/45-libfontbox-java_1%3a1.8.16-2_all.deb …
Unpacking libfontbox-java (1:1.8.16-2) …
Selecting previously unselected package libpdfbox-java.
Preparing to unpack …/46-libpdfbox-java_1%3a1.8.16-2_all.deb …
Unpacking libpdfbox-java (1:1.8.16-2) …
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack …/47-texlive-latex-recommended_2021.20220204-1_all.deb …
Unpacking texlive-latex-recommended (2021.20220204-1) …
Selecting previously unselected package texlive-pictures.
Preparing to unpack …/48-texlive-pictures_2021.20220204-1_all.deb …
Unpacking texlive-pictures (2021.20220204-1) …
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack …/49-texlive-latex-extra_2021.20220204-1_all.deb …
Unpacking texlive-latex-extra (2021.20220204-1) …
Selecting previously unselected package texlive-plain-generic.
Preparing to unpack …/50-texlive-plain-generic_2021.20220204-1_all.deb …
Unpacking texlive-plain-generic (2021.20220204-1) …
Selecting previously unselected package tipa.
Preparing to unpack …/51-tipa_2%3a1.3-21_all.deb …
Unpacking tipa (2:1.3-21) …
Selecting previously unselected package texlive-xetex.
Preparing to unpack …/52-texlive-xetex_2021.20220204-1_all.deb …
Unpacking texlive-xetex (2021.20220204-1) …
Setting up fonts-lato (2.0-2.1) …
Setting up fonts-noto-mono (20201225-1build1) …
Setting up libwoff1:amd64 (1.0.2-1build4) …
Setting up libtexlua53:amd64 (2021.20210626.59705-1ubuntu0.2) …
Setting up libijs-0.35:amd64 (0.35-15build2) …
Setting up libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.2) …
Setting up libfontbox-java (1:1.8.16-2) …
Setting up rubygems-integration (1.18) …
Setting up libzzip-0-13:amd64 (0.13.72+dfsg.1-1.1) …
Setting up fonts-urw-base35 (20200910-1) …
Setting up poppler-data (0.4.11-1) …
Setting up tex-common (6.17) …
update-language: texlive-base not installed and configured, doing nothing!
Setting up libjbig2dec0:amd64 (0.19-3build2) …
Setting up libteckit0:amd64 (2.5.11+ds1-1) …
Setting up libapache-pom-java (18-1) …
Setting up ruby-net-telnet (0.1.1-2) …
Setting up xfonts-encodings (1:1.0.5-0ubuntu2) …
```

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Setting up t1utils (1.41-4build2) …
Setting up libidn12:amd64 (1.38-4ubuntu1) …
Setting up fonts-texgyre (20180621-3.1) …
Setting up libkpathsea6:amd64 (2021.20210626.59705-1ubuntu0.2) …
Setting up ruby-webrick (1.7.0-3ubuntu0.2) …
Setting up fonts-lmodern (2.004.5-6.1) …
Setting up fonts-droid-fallback (1:6.0.1r16-1.1build1) …
Setting up ruby-xmlrpc (0.3.2-1ubuntu0.1) …
Setting up libsynctex2:amd64 (2021.20210626.59705-1ubuntu0.2) …
Setting up libgs9-common (9.55.0~dfsg1-0ubuntu5.12) …
Setting up teckit (2.5.11+ds1-1) …
Setting up libpdfbox-java (1:1.8.16-2) …
Setting up libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.12) …
Setting up preview-latex-style (12.2-1ubuntu1) …
Setting up libcommons-parent-java (43-1) …
Setting up dvisvgm (2.13.1-1) …
Setting up libcommons-logging-java (1.2-2) …
Setting up xfonts-utils (1:7.7+6build2) …
Setting up libptexenc1:amd64 (2021.20210626.59705-1ubuntu0.2) …
Setting up texlive-binaries (2021.20210626.59705-1ubuntu0.2) …
update-alternatives: using /usr/bin/xdvi-xaw to provide /usr/bin/xdvi.bin
(xdvi.bin) in auto mode
update-alternatives: using /usr/bin/bibtex.original to provide /usr/bin/bibtex
(bibtex) in auto mode
Setting up lmodern (2.004.5-6.1) …
Setting up texlive-base (2021.20220204-1) …
/usr/bin/ucfr
/usr/bin/ucfr
/usr/bin/ucfr
/usr/bin/ucfr
mktexlsr: Updating /var/lib/texmf/ls-R-TEXLIVEDIST…
mktexlsr: Updating /var/lib/texmf/ls-R-TEXMFMAIN…
mktexlsr: Updating /var/lib/texmf/ls-R…
mktexlsr: Done.
tl-paper: setting paper size for dvips to a4:
/var/lib/texmf/dvips/config/config-paper.ps
tl-paper: setting paper size for dvipdfmx to a4:
/var/lib/texmf/dvipdfmx/dvipdfmx-paper.cfg
tl-paper: setting paper size for xdvi to a4: /var/lib/texmf/xdvi/XDvi-paper
tl-paper: setting paper size for pdftex to a4: /var/lib/texmf/tex/generic/tex-
ini-files/pdftexconfig.tex
Setting up tex-gyre (20180621-3.1) …
Setting up texlive-plain-generic (2021.20220204-1) …
Setting up texlive-latex-base (2021.20220204-1) …
Setting up texlive-latex-recommended (2021.20220204-1) …
Setting up texlive-pictures (2021.20220204-1) …
Setting up texlive-fonts-recommended (2021.20220204-1) …
Setting up tipa (2:1.3-21) …
```

```
Setting up texlive-latex-extra (2021.20220204-1) …
Setting up texlive-xetex (2021.20220204-1) …
Setting up rake (13.0.6-2) …
Setting up libruby3.0:amd64 (3.0.2-7ubuntu2.11) …
Setting up ruby3.0 (3.0.2-7ubuntu2.11) …
Setting up ruby (1:3.0~exp1) …
Setting up ruby-rubygems (3.3.5-2ubuntu1.1) …
Processing triggers for man-db (2.10.2-1) …
Processing triggers for mailcap (3.70+nmu1ubuntu1) …
Processing triggers for fontconfig (2.13.1-4.2ubuntu5) …
Processing triggers for libc-bin (2.35-0ubuntu3.8) …
/sbin/ldconfig.real: /usr/local/lib/libur_loader.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_opencl.so.0 is not a symbolic
link

/sbin/ldconfig.real: /usr/local/lib/libtcm.so.1 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_level_zero.so.0 is not a
symbolic link

/sbin/ldconfig.real: /usr/local/lib/libumf.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtcm_debug.so.1 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_0.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_level_zero_v2.so.0 is not a
symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc.so.2 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbb.so.12 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 is not a symbolic
link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_5.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libhwloc.so.15 is not a symbolic link

Processing triggers for tex-common (6.17) …
Running updmap-sys. This may take some time… done.
Running mktexlsr /var/lib/texmf … done.
Building format(s) --all.
        This may take some time… done.
```

```
Reading package lists… Done
Building dependency tree… Done
Reading state information… Done
pandoc is already the newest version (2.9.2.1-3ubuntu2).
0 upgraded, 0 newly installed, 0 to remove and 45 not upgraded.
Requirement already satisfied: nbconvert in /usr/local/lib/python3.12/dist-
packages (7.16.6)
Requirement already satisfied: beautifulsoup4 in /usr/local/lib/python3.12/dist-
packages (from nbconvert) (4.13.5)
Requirement already satisfied: bleach!=5.0.0 in /usr/local/lib/python3.12/dist-
packages (from bleach[css]!=5.0.0->nbconvert) (6.2.0)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.12/dist-
packages (from nbconvert) (0.7.1)
Requirement already satisfied: jinja2>=3.0 in /usr/local/lib/python3.12/dist-
packages (from nbconvert) (3.1.6)
Requirement already satisfied: jupyter-core>=4.7 in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (5.8.1)
Requirement already satisfied: jupyterlab-pygments in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (0.3.0)
Requirement already satisfied: markupsafe>=2.0 in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (3.0.2)
Requirement already satisfied: mistune<4,>=2.0.3 in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (3.1.4)
Requirement already satisfied: nbclient>=0.5.0 in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (0.10.2)
Requirement already satisfied: nbformat>=5.7 in /usr/local/lib/python3.12/dist-
packages (from nbconvert) (5.10.4)
Requirement already satisfied: packaging in /usr/local/lib/python3.12/dist-
packages (from nbconvert) (25.0)
Requirement already satisfied: pandocfilters>=1.4.1 in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (1.5.1)
Requirement already satisfied: pygments>=2.4.1 in
/usr/local/lib/python3.12/dist-packages (from nbconvert) (2.19.2)
Requirement already satisfied: traitlets>=5.1 in /usr/local/lib/python3.12/dist-
packages (from nbconvert) (5.7.1)
Requirement already satisfied: webencodings in /usr/local/lib/python3.12/dist-
packages (from bleach!=5.0.0->bleach[css]!=5.0.0->nbconvert) (0.5.1)
Requirement already satisfied: tinycss2<1.5,>=1.1.0 in
/usr/local/lib/python3.12/dist-packages (from bleach[css]!=5.0.0->nbconvert)
(1.4.0)
Requirement already satisfied: platformdirs>=2.5 in
/usr/local/lib/python3.12/dist-packages (from jupyter-core>=4.7->nbconvert)
(4.4.0)
Requirement already satisfied: jupyter-client>=6.1.12 in
/usr/local/lib/python3.12/dist-packages (from nbclient>=0.5.0->nbconvert)
(7.4.9)
Requirement already satisfied: fastjsonschema>=2.15 in
/usr/local/lib/python3.12/dist-packages (from nbformat>=5.7->nbconvert) (2.21.2)
```

Requirement already satisfied: jsonschema>=2.6 in
/usr/local/lib/python3.12/dist-packages (from nbformat>=5.7->nbconvert) (4.25.1)
Requirement already satisfied: soupsieve>1.2 in /usr/local/lib/python3.12/dist-
packages (from beautifulsoup4->nbconvert) (2.8)
Requirement already satisfied: typing-extensions>=4.0.0 in
/usr/local/lib/python3.12/dist-packages (from beautifulsoup4->nbconvert)
(4.15.0)
Requirement already satisfied: attrs>=22.2.0 in /usr/local/lib/python3.12/dist-
packages (from jsonschema>=2.6->nbformat>=5.7->nbconvert) (25.3.0)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in
/usr/local/lib/python3.12/dist-packages (from
jsonschema>=2.6->nbformat>=5.7->nbconvert) (2025.4.1)
Requirement already satisfied: referencing>=0.28.4 in
/usr/local/lib/python3.12/dist-packages (from
jsonschema>=2.6->nbformat>=5.7->nbconvert) (0.36.2)
Requirement already satisfied: rpds-py>=0.7.1 in /usr/local/lib/python3.12/dist-
packages (from jsonschema>=2.6->nbformat>=5.7->nbconvert) (0.27.1)
Requirement already satisfied: entrypoints in /usr/local/lib/python3.12/dist-
packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert) (0.4)
Requirement already satisfied: nest-asyncio>=1.5.4 in
/usr/local/lib/python3.12/dist-packages (from jupyter-
client>=6.1.12->nbclient>=0.5.0->nbconvert) (1.6.0)
Requirement already satisfied: python-dateutil>=2.8.2 in
/usr/local/lib/python3.12/dist-packages (from jupyter-
client>=6.1.12->nbclient>=0.5.0->nbconvert) (2.9.0.post0)
Requirement already satisfied: pyzmq>=23.0 in /usr/local/lib/python3.12/dist-
packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert) (26.2.1)
Requirement already satisfied: tornado>=6.2 in /usr/local/lib/python3.12/dist-
packages (from jupyter-client>=6.1.12->nbclient>=0.5.0->nbconvert) (6.4.2)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-
packages (from python-dateutil>=2.8.2->jupyter-
client>=6.1.12->nbclient>=0.5.0->nbconvert) (1.17.0)

[40]: ```
!jupyter nbconvert --to pdf "HW0(2).ipynb"
```

```
[NbConvertApp] Converting notebook HW0(2).ipynb to pdf
[NbConvertApp] Support files will be in HW0(2)_files/
[NbConvertApp] Making directory ./HW0(2)_files
[NbConvertApp] Writing 84042 bytes to notebook.tex
[NbConvertApp] Building PDF
[NbConvertApp] Running xelatex 3 times: ['xelatex', 'notebook.tex', '-quiet']
[NbConvertApp] Running bibtex 1 time: ['bibtex', 'notebook']
[NbConvertApp] WARNING | bibtex had problems, most likely because there were no
citations
[NbConvertApp] PDF successfully created
[NbConvertApp] Writing 1978178 bytes to HW0(2).pdf
```

[ ]: