

HW7

March 22, 2025

Please complete the `NotImplemented` parts of the code cells and write your answers in the markdown cells designated for your response to any questions asked. The tag `# AUTOGRADED` (all caps, with a space after `#`) should be at the beginning of each autograded code cell, so make sure that you do not change that. You are also not allowed to import any new package other than the ones already imported. Doing so will prevent the autograder from grading your code.

For the code submission, run the last cell in the notebook to create the submission zip file. If you are working in Colab, make sure to download and then upload a copy of the completed notebook itself to its working directory to be included in the zip file. Finally, submit the zip file to Gradescope.

After you finish the assignment and fill in your code and response where needed (all cells should have been run), save the notebook as a PDF using the `jupyter nbconvert --to pdf HW7.ipynb` command (via a notebook code cell or the command line directly) and submit the PDF to Gradescope under the PDF submission item. If you cannot get this to work locally, you can upload the notebook to Google Colab and create the PDF there. You can find the notebook containing the instruction for this on Canvas.

If you are running the notebook locally, make sure you have created a virtual environment (using `conda` for example) and have the proper packages installed. We are working with `python=3.10` and `torch>=2`.

Files to be included in submission:

- `HW7.ipynb`
- `model_config.yaml`
- `train_config.yaml`

```
[1]: """
DO NOT MODIFY THIS CELL OR ADD ANY ADDITIONAL IMPORTS ANYWHERE ELSE IN THIS_
↪NOTEBOOK!
"""

from typing import Sequence, Tuple, Union
from tqdm import tqdm
import numpy as np

import matplotlib.pyplot as plt
plt.rcParams.update({'figure.autolayout': True})

import torch
from torch import nn
```

```

from torch import optim
from torch.optim import lr_scheduler
from torch.nn import functional as F
from torch.utils.data import DataLoader

from google.colab import drive
drive.mount('/content/drive')
import os
os.chdir("/content/drive/MyDrive/24789HW7")

from HW7_utils import AirfoilDataset, VAE_Tracker, plot_airfoils, save_yaml, \
    zip_files

if torch.cuda.is_available():
    Device = 'cuda'
elif torch.backends.mps.is_available():
    Device = 'mps'
else:
    Device = 'cpu'

print(f'Device is {Device}')

```

Mounted at /content/drive
Device is cuda

1 Fundamentals of VAEs (Variational Autoencoders) (30)

1.1 The Encoder

Unlike a plain autoencoder, the encoder of a VAE does not give as output just a single encoding z , but a probability distribution. More specifically, if the input is x and the latent code is z , the encoder now represents $prob(z|x)$, which is the **conditional probability distribution** of z given the observed input x . In the typical VAE, this distribution is assumed to be a normal distribution with learnable mean and variance. In this case, the implementation of the encoder gives as output $\mu_\phi(x)$ and $\sigma_\phi^2(x)$, where ϕ represents the learnable parameters of the encoder. The actual output of the encoder is then the following distribution:

$$q_\phi(z|x) = N\left(\mu_\phi(x), \sigma_\phi^2(x)\right)$$

x can be any kind of data like 1D (vector), 2D(images), or 3D(volumes or videos) data. z can also be of any shape, but is usually a vector of a certain size. For convenience, it is assumed that the different elements of the latent vector are independent random variables, each with its own mean and variance. This makes the covariance matrix diagonal, and the calculations will be element-wise during implementation.

1.2 The Decoder

In theory, the decoder is also a probabilistic function that maps a latent vector z to the **conditional probability distribution** of the data samples x that correspond to that z , denoted as $p(x|z)$. However, this is not the common case in practice as the data is usually high-dimensional and modeling a probability distribution for it is not practically plausible. Therefore, the decoder is usually implemented as a deterministic model that takes as input a latent variable z and gives as output a generated sample \hat{x} . You can also think of this as the mean of $p(x|z)$, not considering the variance.

During Training, the encoder and decoder are trained end-to-end, and the input to the decoder is sampled from the output of the encoder $q(z|x)$, and the output of the decoder is expected to be similar to the original input data.

During generation, We want to generate new samples using the trained decoder. However, we want to be able to assume that the learned encoding of the VAE follows a desired distribution, so we do not have to analyze the learned latent space after training to find out what range in the latent space will lead to good generated samples.

Let's assume we want the learned z to follow a distribution $p(z)$ (called the prior), which is usually a standard normal distribution $N(0, I)$. The mechanism that makes the model learn z to try to follow that distribution, is to add a new term to the loss function, which penalizes the encoded $q(z|x)$ that are too far from the prior distribution $p(z)$. Let's take a closer look on how that works.

1.3 The Loss

The main purpose of a VAE is to generate new data by decoding arbitrary latent vectors sampled from a predefined distribution $p(z)$. Therefore, it has to learn to encode input data to the desired distribution as well.

If the distribution of the latent vector z follows the distribution $p(z)$, the conditional distribution of z given a certain input x is expected to be close to $p(z)$ but more narrowed down or zoomed. This is true for any two dependent random variables (here x and z). Therefore, it is reasonable to include an additional term in the loss function that penalizes the distance of $q_\phi(z|x)$ from $p(z)$.

The final loss function of a VAE is written as:

$$L_{VAE} = L_{rec} + \beta L_{prior}$$

where L_{rec} is the reconstruction loss (the loss for plain autoencoders), L_{prior} penalizes the distance of the conditional distribution $q_\phi(z|x)$ from the prior distribution $p(z)$, and β balances the contribution of this term to the total loss. With this loss function, the encoder is no longer free to encode the data to any arbitrary range of latent values. Those values have to be reasonably close to the prior distribution $p(z)$ so we can assume the eventual distribution of the data in the learned latent space somewhat resembles the presumed distribution $p(z)$.

The most common function used to calculate the distance between two probability distributions is the **Kullback–Leibler (KL) divergence**. For two arbitrary distributions, it is defined as follows:

$$D_{KL}\left(P(x)||Q(x)\right) = \mathbb{E}_{x \sim P(x)} \left[-\log\left(\frac{Q(x)}{P(x)}\right) \right] = \int -\log\left(\frac{Q(x)}{P(x)}\right) P(x) dx$$

Where \mathbb{E} is the symbol for **expected value**. The theoretical background and derivation of the KL-divergence comes from maximizing the likelihood of the input data $p(x|z)$ based on the assumed prior $p(z)$ and calculated posterior $q_\phi(z|x)$ from the encoder. You can look it up if you are interested.

For L_{prior} in the VAE loss, the random variable is the latent vector z , and we replace $P(x)$ with $q_\phi(z|x)$ and replace $Q(x)$ with $p(z)$:

$$D_{KL}(q_\phi(z|x)||p(z)) = \mathbb{E}_{z \sim q(z|x)} \left[-\log \left(\frac{p(z)}{q_\phi(z|x)} \right) \right] = \int -\log \left(\frac{p(z)}{q_\phi(z|x)} \right) q_\phi(z|x) dz$$

1.4 QUESTION (15)

If z is a scalar (1 dimension), calculate $D_{KL}(q(z|x)||p(z))$ in terms of μ and σ (you can drop (x) from $\mu(x), \sigma(x)$ for convenience in your derivation). Write your answer as latex code lines, where each line is between two lines of `$$`. Take a look at the code for the markdown cells with equations to understand how it works. You can also write your solution on paper, and send a picture of it to ChatGPT and ask it to give you the latex code for it.

Here's what you need to get started:

$$q(z|x) = N(\mu, \sigma^2) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$$

$$p(z) = N(0, 1) = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}$$

If $z \sim N(\mu, \sigma^2)$, then:

$$\mathbb{E}[z] = \mu \quad \mathbb{E}[z^2] = \mu^2 + \sigma^2$$

Also, remember that \mathbb{E} is a linear operator, meaning:

$$\mathbb{E}[ax + b] = a\mathbb{E}[x] + b$$

where x is a random variable, and a, b are independent from x .

For convenience, no need to write the distribution under \mathbb{E} . It is implied that the expected value is being taken with respect to $z \sim N(\mu, \sigma^2)$. You **DO NOT** need to calculate any integrals here. Everything is represented as expected values, and calculated using the hints above. You can check your final answer by implementing the function and submitting your code to the autograder. 5 points is given if the final answer is correct, and 10 points is for your derivation.

RESPONSE:

$$D_{KL} = \mathbb{E} \left[-\log \left(\frac{p(z)}{q(z|x)} \right) \right] =$$

[2]: `# AUTOGRADED (5)`

```
def D_KL(
    mu: torch.FloatTensor, # shape (batch_size, latent_size),
    logvar: torch.FloatTensor, # shape (batch_size, latent_size),
```

```

    ) -> torch.FloatTensor: # shape ()
    """
    Compute the KL divergence that you derived earlier, elementwise.
    Then, average over the batch dimension and latent dimension.

    mu: mean of q(z/x)
    logvar: Logarithm of variance of q(z/x).
    """
    kld = 0.5 * (mu.pow(2) + logvar.exp() - logvar - 1)

    return torch.mean(kld)

```

```

[3]: """
TEST D_KL
"""
def test_d_kl(seed: int = 0):
    torch.manual_seed(seed)
    mu = torch.randn(10, 5)
    logvar = torch.randn(10, 5)
    assert D_KL(mu, logvar).shape == ()
    return D_KL(mu, logvar)

torch.testing.assert_close(test_d_kl(0), torch.tensor(0.9318599700927734),
    ↪rtol=1e-5, atol=1e-5)
torch.testing.assert_close(test_d_kl(1), torch.tensor(1.0280910730361938),
    ↪rtol=1e-5, atol=1e-5)
torch.testing.assert_close(test_d_kl(2), torch.tensor(0.853870153427124),
    ↪rtol=1e-5, atol=1e-5)

```

1.5 QUESTION (10)

As you learned, the total loss consists of the reconstruction loss, and the prior loss which encourages the model to learn a latent encoding with a distribution close to the assumed prior distribution.

$$L_{VAE} = L_{rec} + \beta L_{prior}$$

The balance between the two terms is decided by the hyperparameter β . What do you think happens if β is too large (5 points) or too small (5 points)? How will the generated samples be affected in terms of **quality** and **diversity**?

Hint: Think about what happens if the loss consists of only one of the terms, and remember that during data generations, z is going to be sampled from $p(z)$ anyway. You can also verify your answer in the next section by trying different values of **beta**!

RESPONSE:

When beta is too large, the prior loss learning curve will quickly converge to a minimum. The most intuitive consequence is that the images restored by the trained model look almost exactly the same. This is because large beta leads to over-regularization.

When beta is too small, reconstruction loss will dominate, and it is not difficult to imagine that the model will overfit.

2 Implement and train a VAE to generate airfoils (75)

You are provided with the UIUC airfoil dataset consisting of 1547 airfoil profiles. The functions to load and visualize the data are provided in `HW7_utils.py`. Let's take a look at the dataset. Each sample consists of the y-coordinates of points at pre-defined locations on the x-axis, as well as the name of the airfoil. You will not need the names.

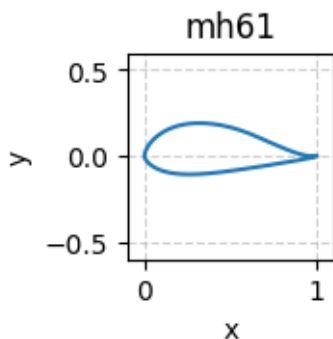
```
[4]: airfoil_dataset = AirfoilDataset()
      print(f'dataset has {len(airfoil_dataset)} samples')
```

dataset has 1547 samples

```
[5]: sample_idx = 431
      y, name = airfoil_dataset[sample_idx]
      print(f'y is {type(y)} and has shape {y.shape} and dtype {y.dtype}')
```

y is <class 'numpy.ndarray'> and has shape (200,) and dtype float32

```
[6]: airfoil_dataset.plot(idx=0)
```



2.1 Implement a VAE (50)

Mostly, the implementation is similar to a plain autoencoder, with the exception that the encoder now gives two outputs μ and σ . Usually, the output dimension of the encoder is doubled, and half is used as μ (mu) and the other half is used as $\log(\sigma^2)$ (logvar). The reason we work with `logvar` is to not worry about the range. σ has to be positive, but `logvar` can have any value. To split a tensor into several tensor chunks of the same size along a certain axis, use `torch.chunk()`.

HINT: to sample from $N(\mu, \sigma^2)$, use `torch.randn_like()` to sample from $N(0, 1)$ with the right shape, dtype, and device. Then, think how to turn that into a sample from $N(\mu, \sigma^2)$. This is called the *reparameterization trick*.

```
[14]: class Encoder(nn.Module):
    """
    Probabilistic encoder. Output: mu and logvar of  $q(z|x)$ .
    """
    def __init__(
        self,
        input_size: int,
        latent_size: int,
        hidden_size: int = 256
    ):
        super().__init__()

        self.fc1 = nn.Linear(input_size, hidden_size)
        self.fc_mu = nn.Linear(hidden_size, latent_size)
        self.fc_logvar = nn.Linear(hidden_size, latent_size)
        self.relu = nn.ReLU()

    def forward(
        self,
        y: torch.FloatTensor, # shape (batch_size, input_size),
    ) -> Tuple[torch.FloatTensor, torch.FloatTensor]: # mu and logvar
        ↪ of  $q(z|x)$ , both of shape (batch_size, latent_size)

        h = self.relu(self.fc1(y))
        mu = self.fc_mu(h)
        logvar = self.fc_logvar(h)

        return mu, logvar

class Decoder(nn.Module):
    """
    Treat this as a normal decoder.
    """
    def __init__(
        self,
        latent_size: int,
        output_size: int,
        hidden_size: int = 256
    ):
        super().__init__()

        self.fc1 = nn.Linear(latent_size, hidden_size)
        self.fc2 = nn.Linear(hidden_size, output_size)
        self.relu = nn.ReLU()

    def forward(
        self,
```

```

        z: torch.FloatTensor, # shape (batch_size, latent_size),
        ) -> torch.FloatTensor: # y_hat of shape (batch_size, output_size)

    h = self.relu(self.fc1(z))
    y_hat = self.fc2(h)

    return y_hat

class VAE(nn.Module):

    def __init__(
        self,
        input_size: int,
        latent_size: int,
        hidden_size: int = 256
    ):
        super().__init__()
        """
        use the encoder and decoder classes you defined above, like:
        self.encoder = Encoder(...)
        self.decoder = Decoder(...)
        """

        self.latent_size = latent_size
        self.encoder = Encoder(input_size, latent_size, hidden_size)
        self.decoder = Decoder(latent_size, input_size, hidden_size)

    def forward(
        self,
        y: torch.FloatTensor, # shape (batch_size, input_size),
        ) -> Tuple[torch.FloatTensor, torch.FloatTensor, torch.FloatTensor]:
        ↪ # y_hat, mu, logvar
        """
        - forward pass of the encoder, get mu and logvar
        - sample z from the output of the encoder
        - forward pass of the decoder to get y_hat (reconstruction)
        return y_hat, mu, logvar
        """

        mu, logvar = self.encoder(y)

        std = torch.exp(0.5 * logvar)
        eps = torch.randn_like(std)
        z = mu + eps * std

        y_hat = self.decoder(z)
        return y_hat, mu, logvar

    @torch.inference_mode()

```



```

def generate(
    self,
    n_samples: int,
    seed: int = 0,
    device: str = Device,
) -> torch.FloatTensor: # shape (n_samples, input_size)

    torch.manual_seed(seed)
    """
    Set the decoder to evaluation mode and move it to the device.
    sample from  $p(z)$  with the correct shape and device and dtype
    decode them to generate new samples
    """
    torch.manual_seed(seed)

    self.decoder.eval()
    z = torch.randn(n_samples, self.latent_size, device=device)
    y_hat = self.decoder(z)

    return y_hat

```

2.2 Training (10)

In this assignment, we are going to use an iteration-based training loop, rather than a primarily epoch-based training loop. This does not impose any significant change, other than how to configure the learning rate scheduler. The learning rate scheduler is now called at every iteration, so you should keep that in mind when defining the hyperparameters of the scheduler. Fill in the train function where marked by `NotImplemented`.

```

[15]: @torch.enable_grad()
def train_VAE(
    model: VAE,
    train_dataset: AirfoilDataset,
    device = Device,
    plot_freq: int = 100,

    beta: float = 1.,
    rec_loss_fn: nn.Module = nn.MSELoss(),
    optimizer_name: str = 'Adam',
    optimizer_config: dict = dict(),
    lr_scheduler_name: Union[str, None] = None,
    lr_scheduler_config: dict = dict(),
    running_avg_window: int = 20,
    n_iters: int = 1000,
    batch_size: int = 64,
):

```

```

assert beta >= 0

model.train().to(device)

tracker = VAE_Tracker(
    n_iters = n_iters,
    plot_freq = plot_freq,
)

train_loader = DataLoader(train_dataset, batch_size=batch_size,
↪shuffle=True)
optimizer = optim.__getattr__(optimizer_name)(model.parameters(),
↪**optimizer_config)
if lr_scheduler_name is not None:
    scheduler = lr_scheduler.__getattr__(lr_scheduler_name)(optimizer,
↪**lr_scheduler_config)

iter = 0
iter_pbar = tqdm(range(n_iters), desc='Iters', unit='iter', leave=True)

while iter < n_iters:

    for y, name in train_loader:

        y = y.to(device)
        optimizer.zero_grad()

        # Implement forward pass and calculate the loss terms
        y_hat, mu, logvar = model(y)
        rec_loss = rec_loss_fn(y_hat, y)
        prior_loss = D_KL(mu, logvar)
        loss = rec_loss + beta * prior_loss

        loss.backward()
        optimizer.step()

        tracker.update(rec_loss.item(), prior_loss.item(), loss.item())
        running_avg_loss = np.mean(tracker.total_losses[-running_avg_window:
↪])

        if lr_scheduler_name == 'ReduceLROnPlateau':
            scheduler.step(running_avg_loss)
        elif lr_scheduler_name is not None:
            scheduler.step()

        iter_pbar.set_postfix_str(f'L_rec: {rec_loss.item():.6f}, L_prior:
↪{prior_loss.item():.6f}, L_total: {loss.item():.6f}')

```

```

iter_pbar.update(1)
iter += 1
if iter >= n_iters:
    break

```

2.3 Find and train a good model (15)

As usual, find a good set of hyperparameters and train your model. However, you have to evaluate your model qualitatively by looking at some generated samples. Run the cell after the training cell to generate 24 samples with the trained model. If almost all your samples are nice and smooth, and diverse, you get 15 points. If they are a bit noisy like the first (leftmost) example, you get 8-12 points, depending on how nonsmooth they are. If your generated samples are nice but all look exactly the same, your model is suffering from mode collapse and you get 5 points. If they are too nonsmooth, like the last example, you get no points.

Note: Remember to play with `beta` to see what the effect is on the learning curves and the generated samples. The key to get a nice VAE is to find a nice β .

DO NOT CHANGE `input_size` and `latent_size`.

```

[22]: """
      Choose configuration for VAE and train_VAE
      """

model_config = dict(
    input_size = 200,
    latent_size = 10,
    # YOUR CODE
    hidden_size=256
)

train_config = dict(
    beta = 0.008,
    optimizer_name = 'Adam',
    optimizer_config = {'lr': 1e-3},
    lr_scheduler_name = None,
    lr_scheduler_config = {},
    running_avg_window = 20,
    n_iters = 10000,
    batch_size = 128,
)

```

```

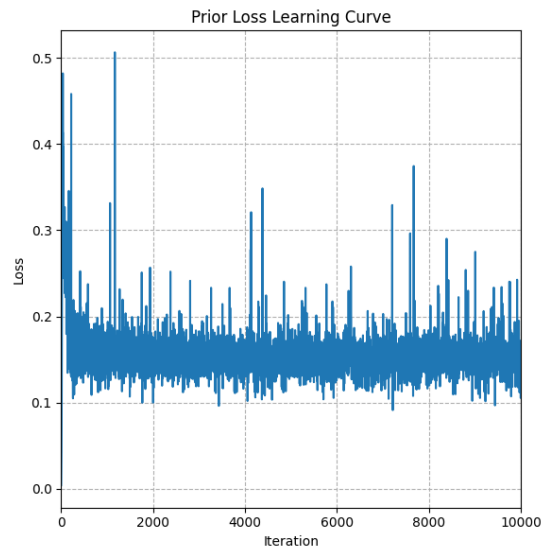
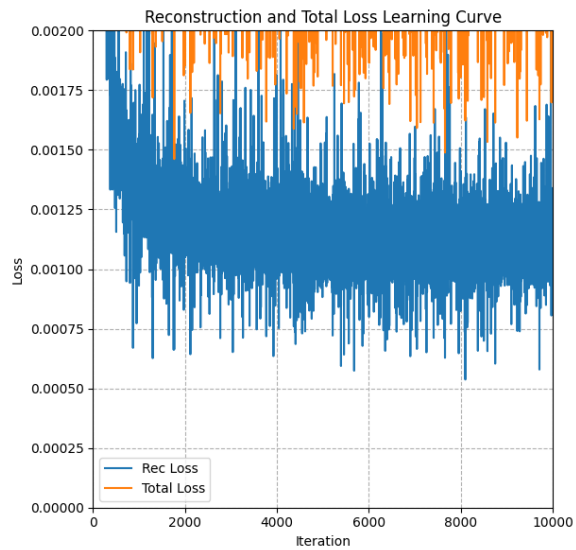
[23]: """
      Train the model and monitor the loss terms.
      Investigate the effect of beta on the reconstruction and prior loss, and the_
      ↪ overall loss.

```

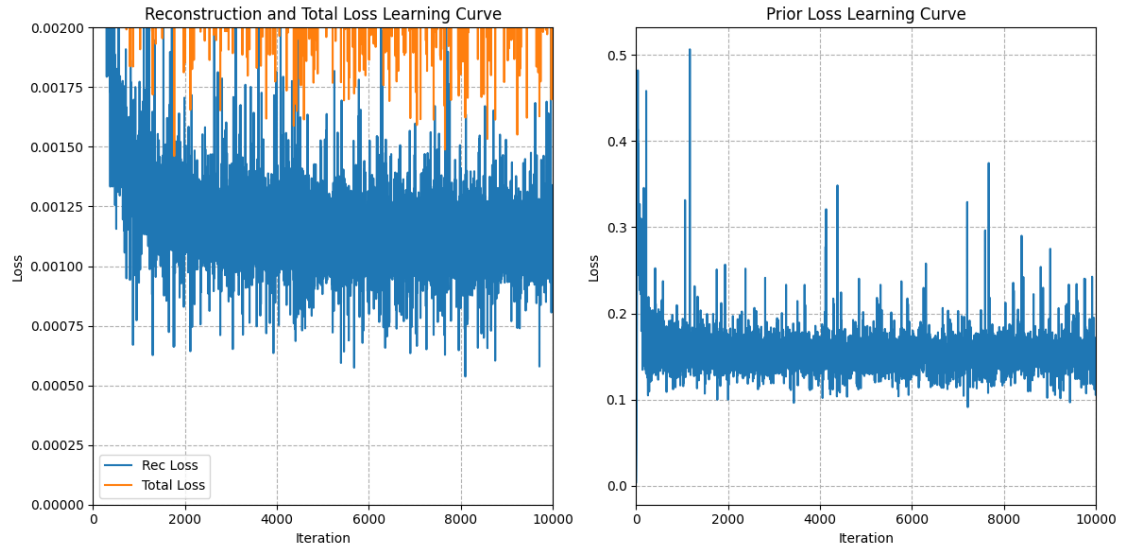
```

"""
if __name__ == '__main__':
    airfoil_dataset = AirfoilDataset()
    model = VAE(**model_config)
    train_VAE(
        model = model,
        train_dataset = airfoil_dataset,
        device = Device,
        plot_freq = 100,
        **train_config,
    )

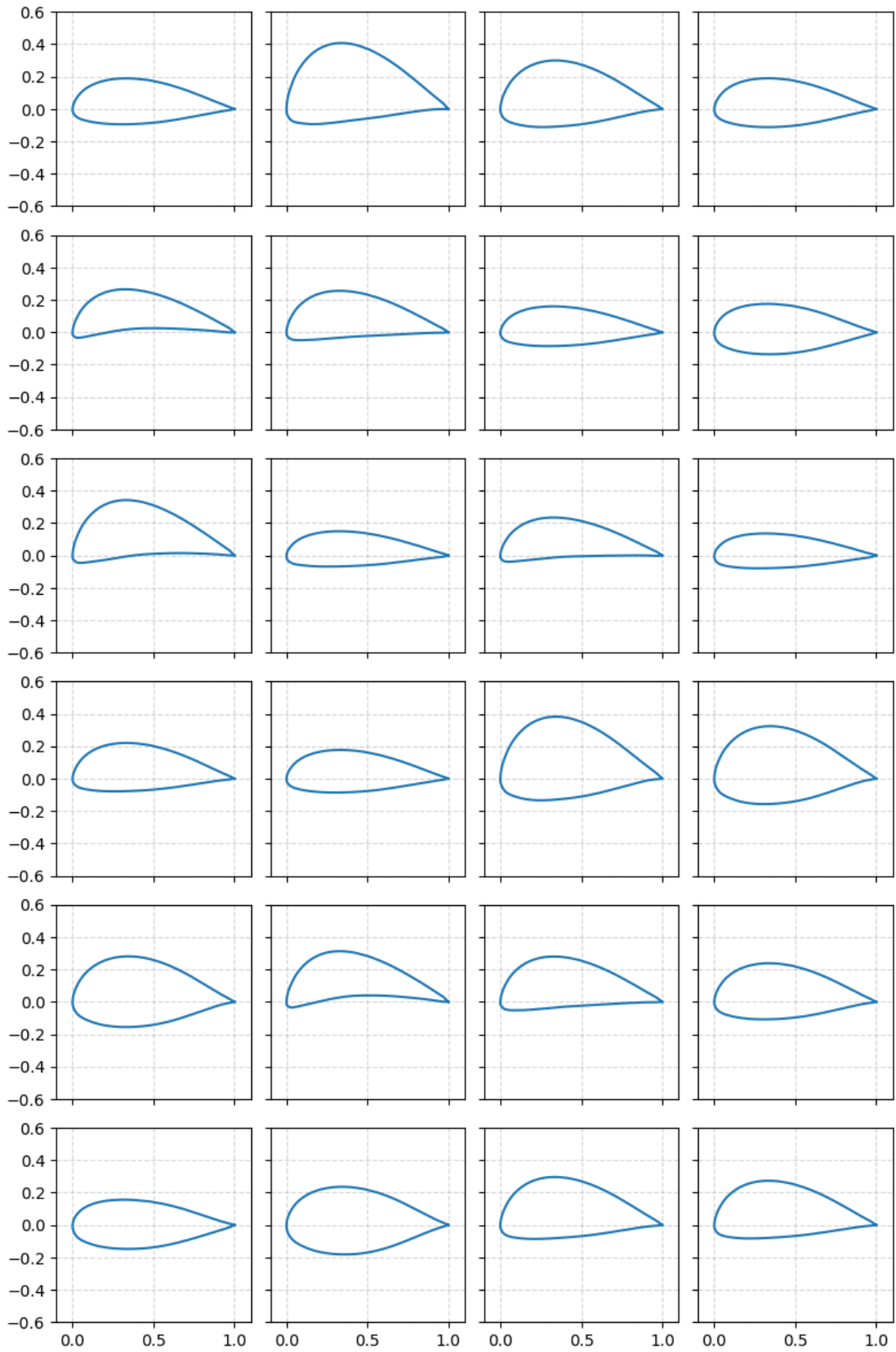
```



Iters: 100%| | 10000/10000 [01:40<00:00, 99.69iter/s, L_rec: 0.001280,
 L_prior: 0.150207, L_total: 0.002481]



```
[21]: """
After training, take a look at generated samples.
If you tune beta properly, you should get high quality and diverse generation.
"""
if __name__ == '__main__':
    random_seed = 0 # You can change this, but it may not help you that much.
    generated_samples = model.generate(n_samples=24, seed=random_seed,
    ↪device=Device)
    plot_airfoils(airfoil_dataset.get_x(), generated_samples.cpu().numpy())
```



3 Zip submission files

You can run the following cell to zip the generated files for submission.

If you are on Colab, make sure to download and then upload a completed copy of the notebook to the working directory so the code can detect and include it in the zip file for submission.

```
[24]: save_yaml(model_config, 'model_config.yaml')
      save_yaml(train_config, 'train_config.yaml')

      submission_files = ['HW7.ipynb', 'model_config.yaml', 'train_config.yaml']
      zip_files('HW7_submission.zip', submission_files)
```

```
[25]: !apt-get install texlive texlive-xetex texlive-latex-extra pandoc
```

```
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
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 libcbmark-gfm-extensions0.29.0.gfm.3
libcbmark-gfm0.29.0.gfm.3
  libcommons-logging-java libcommons-parent-java libfontbox-java libfontenc1
libgs9 libgs9-common
  libidn12 libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1
libruby3.0 libsynchronet2
  libteckit0 libtexlua53 libtexluajit2 libwoff1 libzzip-0-13 lmodern pandoc-data
poppler-data
  preview-latex-style rake ruby ruby-net-telnet ruby-rubygems ruby-webrick ruby-
xmlrpc ruby3.0
  rubygems-integration tlutils teckit tex-common tex-gyre texlive-base texlive-
binaries
  texlive-fonts-recommended texlive-latex-base texlive-latex-recommended
texlive-pictures
  texlive-plain-generic 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 texlive-
luatex
  pandoc-citeproc context wkhtmltopdf librsvg2-bin groff ghc nodejs php python
libjs-mathjax
  libjs-katex citation-style-language-styles 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-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 libcmark-gfm-extensions0.29.0.gfm.3
libcmark-gfm0.29.0.gfm.3
  libcommons-logging-java libcommons-parent-java libfontbox-java libfontenc1
libgs9 libgs9-common
  libidn12 libijs-0.35 libjbig2dec0 libkpathsea6 libpdfbox-java libptexenc1
libruby3.0 libsynchronet2
  libteckit0 libtexlua53 libtexluaajit2 libwoff1 libzzip-0-13 lmodern pandoc
pandoc-data
  poppler-data preview-latex-style rake ruby ruby-net-telnet ruby-rubygems ruby-
webrick ruby-xmlrpc
  ruby3.0 rubygems-integration tlutils teckit tex-common tex-gyre texlive
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, 59 newly installed, 0 to remove and 29 not upgraded.
Need to get 202 MB of archives.
After this operation, 728 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 9.55.0-0ubuntu5.10 [752 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~dfsg1-0ubuntu5.10 [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 libcmark-
 gfm0.29.0.gfm.3 amd64 0.29.0.gfm.3-3 [115 kB]
 Get:19 <http://archive.ubuntu.com/ubuntu> jammy/universe amd64 libcmark-gfm-
 extensions0.29.0.gfm.3 amd64 0.29.0.gfm.3-3 [25.1 kB]
 Get:20 <http://archive.ubuntu.com/ubuntu> jammy/universe amd64 libcommons-parent-
 java all 43-1 [10.8 kB]
 Get:21 <http://archive.ubuntu.com/ubuntu> jammy/universe amd64 libcommons-logging-
 java all 1.2-2 [60.3 kB]
 Get:22 <http://archive.ubuntu.com/ubuntu> jammy/main amd64 libfontenc1 amd64
 1:1.1.4-1build3 [14.7 kB]
 Get:23 <http://archive.ubuntu.com/ubuntu> jammy-updates/main amd64 libptexenc1
 amd64 2021.20210626.59705-1ubuntu0.2 [39.1 kB]
 Get:24 <http://archive.ubuntu.com/ubuntu> jammy/main amd64 rubygems-integration
 all 1.18 [5,336 B]
 Get:25 <http://archive.ubuntu.com/ubuntu> jammy-updates/main amd64 ruby3.0 amd64
 3.0.2-7ubuntu2.8 [50.1 kB]
 Get:26 <http://archive.ubuntu.com/ubuntu> jammy/main amd64 ruby-rubygems all
 3.3.5-2 [228 kB]
 Get:27 <http://archive.ubuntu.com/ubuntu> jammy/main amd64 ruby amd64 1:3.0~exp1
 [5,100 B]
 Get:28 <http://archive.ubuntu.com/ubuntu> jammy/main amd64 rake all 13.0.6-2 [61.7
 kB]
 Get:29 <http://archive.ubuntu.com/ubuntu> jammy/main amd64 ruby-net-telnet all
 0.1.1-2 [12.6 kB]
 Get:30 <http://archive.ubuntu.com/ubuntu> jammy-updates/main amd64 ruby-webrick
 all 1.7.0-3ubuntu0.1 [52.1 kB]
 Get:31 <http://archive.ubuntu.com/ubuntu> jammy-updates/main amd64 ruby-xmlrpc all
 0.3.2-1ubuntu0.1 [24.9 kB]
 Get:32 <http://archive.ubuntu.com/ubuntu> jammy-updates/main amd64 libruby3.0

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amd64 3.0.2-7ubuntu2.8 [5,113 kB]
Get:33 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsynctex2
amd64 2021.20210626.59705-1ubuntu0.2 [55.6 kB]
Get:34 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libteckit0 amd64
2.5.11+ds1-1 [421 kB]
Get:35 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexlua53
amd64 2021.20210626.59705-1ubuntu0.2 [120 kB]
Get:36 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libtexluajit2
amd64 2021.20210626.59705-1ubuntu0.2 [267 kB]
Get:37 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libzzip-0-13 amd64
0.13.72+dfsg.1-1.1 [27.0 kB]
Get:38 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-encodings all
1:1.0.5-0ubuntu2 [578 kB]
Get:39 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-utils amd64
1:7.7+6build2 [94.6 kB]
Get:40 http://archive.ubuntu.com/ubuntu jammy/universe amd64 lmodern all
2.004.5-6.1 [9,471 kB]
Get:41 http://archive.ubuntu.com/ubuntu jammy/universe amd64 pandoc-data all
2.9.2.1-3ubuntu2 [81.8 kB]
Get:42 http://archive.ubuntu.com/ubuntu jammy/universe amd64 pandoc amd64
2.9.2.1-3ubuntu2 [20.3 MB]
Get:43 http://archive.ubuntu.com/ubuntu jammy/universe amd64 preview-latex-style
all 12.2-1ubuntu1 [185 kB]
Get:44 http://archive.ubuntu.com/ubuntu jammy/main amd64 t1utils amd64
1.41-4build2 [61.3 kB]
Get:45 http://archive.ubuntu.com/ubuntu jammy/universe amd64 teckit amd64
2.5.11+ds1-1 [699 kB]
Get:46 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tex-gyre all
20180621-3.1 [6,209 kB]
Get:47 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 texlive-
binaries amd64 2021.20210626.59705-1ubuntu0.2 [9,860 kB]
Get:48 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-base all
2021.20220204-1 [21.0 MB]
Get:49 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-fonts-
recommended all 2021.20220204-1 [4,972 kB]
Get:50 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-base
all 2021.20220204-1 [1,128 kB]
Get:51 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-
recommended all 2021.20220204-1 [14.4 MB]
Get:52 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive all
2021.20220204-1 [14.3 kB]
Get:53 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libfontbox-java all
1:1.8.16-2 [207 kB]
Get:54 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libpdfbox-java all
1:1.8.16-2 [5,199 kB]
Get:55 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-pictures
all 2021.20220204-1 [8,720 kB]
Get:56 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-latex-extra

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all 2021.20220204-1 [13.9 MB]
Get:57 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-plain-
generic all 2021.20220204-1 [27.5 MB]
Get:58 http://archive.ubuntu.com/ubuntu jammy/universe amd64 tipa all 2:1.3-21
[2,967 kB]
Get:59 http://archive.ubuntu.com/ubuntu jammy/universe amd64 texlive-xetex all
2021.20220204-1 [12.4 MB]
Fetched 202 MB in 14s (14.3 MB/s)
Extracting templates from packages: 100%
Preconfiguring packages ...
Selecting previously unselected package fonts-droid-fallback.
(Reading database ... 126209 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~dfsg1-0ubuntu5.10_all.deb ...
Unpacking libgs9-common (9.55.0~dfsg1-0ubuntu5.10) ...
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~dfsg1-0ubuntu5.10_amd64.deb ...
Unpacking libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.10) ...
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 ...

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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 libcmark-gfm0.29.0.gfm.3:amd64.
Preparing to unpack .../17-libcmark-gfm0.29.0.gfm.3_0.29.0.gfm.3-3_amd64.deb ...
Unpacking libcmark-gfm0.29.0.gfm.3:amd64 (0.29.0.gfm.3-3) ...
Selecting previously unselected package libcmark-gfm-
extensions0.29.0.gfm.3:amd64.
Preparing to unpack .../18-libcmark-gfm-
extensions0.29.0.gfm.3_0.29.0.gfm.3-3_amd64.deb ...
Unpacking libcmark-gfm-extensions0.29.0.gfm.3:amd64 (0.29.0.gfm.3-3) ...
Selecting previously unselected package libcommons-parent-java.
Preparing to unpack .../19-libcommons-parent-java_43-1_all.deb ...
Unpacking libcommons-parent-java (43-1) ...
Selecting previously unselected package libcommons-logging-java.
Preparing to unpack .../20-libcommons-logging-java_1.2-2_all.deb ...
Unpacking libcommons-logging-java (1.2-2) ...
Selecting previously unselected package libfontenc1:amd64.
Preparing to unpack .../21-libfontenc1_1%3a1.1.4-1build3_amd64.deb ...
Unpacking libfontenc1:amd64 (1:1.1.4-1build3) ...
Selecting previously unselected package libptexenc1:amd64.
Preparing to unpack .../22-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 .../23-rubygems-integration_1.18_all.deb ...
Unpacking rubygems-integration (1.18) ...
Selecting previously unselected package ruby3.0.
Preparing to unpack .../24-ruby3.0_3.0.2-7ubuntu2.8_amd64.deb ...
Unpacking ruby3.0 (3.0.2-7ubuntu2.8) ...
Selecting previously unselected package ruby-rubygems.
Preparing to unpack .../25-ruby-rubygems_3.3.5-2_all.deb ...
Unpacking ruby-rubygems (3.3.5-2) ...
Selecting previously unselected package ruby.
Preparing to unpack .../26-ruby_1%3a3.0~exp1_amd64.deb ...

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Unpacking ruby (1:3.0~exp1) ...
Selecting previously unselected package rake.
Preparing to unpack .../27-rake_13.0.6-2_all.deb ...
Unpacking rake (13.0.6-2) ...
Selecting previously unselected package ruby-net-telnet.
Preparing to unpack .../28-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 .../29-ruby-webrick_1.7.0-3ubuntu0.1_all.deb ...
Unpacking ruby-webrick (1.7.0-3ubuntu0.1) ...
Selecting previously unselected package ruby-xmlrpc.
Preparing to unpack .../30-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 .../31-libruby3.0_3.0.2-7ubuntu2.8_amd64.deb ...
Unpacking libruby3.0:amd64 (3.0.2-7ubuntu2.8) ...
Selecting previously unselected package libsyntax2:amd64.
Preparing to unpack .../32-libsyntax2_2021.20210626.59705-1ubuntu0.2_amd64.deb
...
Unpacking libsyntax2:amd64 (2021.20210626.59705-1ubuntu0.2) ...
Selecting previously unselected package libteckit0:amd64.
Preparing to unpack .../33-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 .../34-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
.../35-libtexluajit2_2021.20210626.59705-1ubuntu0.2_amd64.deb ...
Unpacking libtexluajit2:amd64 (2021.20210626.59705-1ubuntu0.2) ...
Selecting previously unselected package libzip-0-13:amd64.
Preparing to unpack .../36-libzip-0-13_0.13.72+dfsg.1-1.1_amd64.deb ...
Unpacking libzip-0-13:amd64 (0.13.72+dfsg.1-1.1) ...
Selecting previously unselected package xfonts-encodings.
Preparing to unpack .../37-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 .../38-xfonts-utils_1%3a7.7+6build2_amd64.deb ...
Unpacking xfonts-utils (1:7.7+6build2) ...
Selecting previously unselected package lmodern.
Preparing to unpack .../39-lmodern_2.004.5-6.1_all.deb ...
Unpacking lmodern (2.004.5-6.1) ...
Selecting previously unselected package pandoc-data.
Preparing to unpack .../40-pandoc-data_2.9.2.1-3ubuntu2_all.deb ...
Unpacking pandoc-data (2.9.2.1-3ubuntu2) ...
Selecting previously unselected package pandoc.
Preparing to unpack .../41-pandoc_2.9.2.1-3ubuntu2_amd64.deb ...

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Unpacking pandoc (2.9.2.1-3ubuntu2) ...
Selecting previously unselected package preview-latex-style.
Preparing to unpack .../42-preview-latex-style_12.2-1ubuntu1_all.deb ...
Unpacking preview-latex-style (12.2-1ubuntu1) ...
Selecting previously unselected package tlutils.
Preparing to unpack .../43-tlutils_1.41-4build2_amd64.deb ...
Unpacking tlutils (1.41-4build2) ...
Selecting previously unselected package teckit.
Preparing to unpack .../44-teckit_2.5.11+ds1-1_amd64.deb ...
Unpacking teckit (2.5.11+ds1-1) ...
Selecting previously unselected package tex-gyre.
Preparing to unpack .../45-tex-gyre_20180621-3.1_all.deb ...
Unpacking tex-gyre (20180621-3.1) ...
Selecting previously unselected package texlive-binaries.
Preparing to unpack .../46-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 .../47-texlive-base_2021.20220204-1_all.deb ...
Unpacking texlive-base (2021.20220204-1) ...
Selecting previously unselected package texlive-fonts-recommended.
Preparing to unpack .../48-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 .../49-texlive-latex-base_2021.20220204-1_all.deb ...
Unpacking texlive-latex-base (2021.20220204-1) ...
Selecting previously unselected package texlive-latex-recommended.
Preparing to unpack .../50-texlive-latex-recommended_2021.20220204-1_all.deb ...
Unpacking texlive-latex-recommended (2021.20220204-1) ...
Selecting previously unselected package texlive.
Preparing to unpack .../51-texlive_2021.20220204-1_all.deb ...
Unpacking texlive (2021.20220204-1) ...
Selecting previously unselected package libfontbox-java.
Preparing to unpack .../52-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 .../53-libpdfbox-java_1%3a1.8.16-2_all.deb ...
Unpacking libpdfbox-java (1:1.8.16-2) ...
Selecting previously unselected package texlive-pictures.
Preparing to unpack .../54-texlive-pictures_2021.20220204-1_all.deb ...
Unpacking texlive-pictures (2021.20220204-1) ...
Selecting previously unselected package texlive-latex-extra.
Preparing to unpack .../55-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 .../56-texlive-plain-generic_2021.20220204-1_all.deb ...
Unpacking texlive-plain-generic (2021.20220204-1) ...
Selecting previously unselected package tipa.

```

Preparing to unpack .../57-tipa_2%3a1.3-21_all.deb ...
Unpacking tipa (2:1.3-21) ...
Selecting previously unselected package texlive-xetex.
Preparing to unpack .../58-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 libzip-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 libfontenc1:amd64 (1:1.1.4-1build3) ...
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) ...
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 (1.7.0-3ubuntu0.1) ...
Setting up libcmark-gfm0.29.0.gfm.3:amd64 (0.29.0.gfm.3-3) ...
Setting up fonts-lmodern (2.004.5-6.1) ...
Setting up libcmark-gfm-extensions0.29.0.gfm.3:amd64 (0.29.0.gfm.3-3) ...
Setting up fonts-droid-fallback (1:6.0.1r16-1.1build1) ...
Setting up pandoc-data (2.9.2.1-3ubuntu2) ...
Setting up ruby-xmlrpc (0.3.2-1ubuntu0.1) ...
Setting up libsynchronet2:amd64 (2021.20210626.59705-1ubuntu0.2) ...
Setting up libgs9-common (9.55.0~dfsg1-0ubuntu5.10) ...
Setting up teckit (2.5.11+ds1-1) ...
Setting up libpdfbox-java (1:1.8.16-2) ...
Setting up libgs9:amd64 (9.55.0~dfsg1-0ubuntu5.10) ...
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 pandoc (2.9.2.1-3ubuntu2) ...
Setting up texlive-binaries (2021.20210626.59705-1ubuntu0.2) ...

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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 (2021.20220204-1) ...
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 (3.0.2-7ubuntu2.8) ...
Setting up ruby3.0 (3.0.2-7ubuntu2.8) ...
Setting up ruby (1:3.0~exp1) ...
Setting up ruby-rubygems (3.3.5-2) ...
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/libtbbbind_2_5.so.3 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_2_0.so.3 is not a symbolic link

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

```



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/sbin/ldconfig.real: /usr/local/lib/libtbbbind.so.3 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/libtbbmalloc_proxy.so.2 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/libur_loader.so.0 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/libtcm_debug.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/libur_adapter_opencl.so.0 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.

```

```
[26]: !jupyter nbconvert --to pdf '/content/drive/MyDrive/24789HW7/HW7.ipynb'
```

```

[NbConvertApp] Converting notebook /content/drive/MyDrive/24789HW7/HW7.ipynb to
pdf
[NbConvertApp] Support files will be in HW7_files/
[NbConvertApp] Making directory ./HW7_files
[NbConvertApp] Writing 91458 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 415325 bytes to /content/drive/MyDrive/24789HW7/HW7.pdf

```