HW8

March 26, 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 HW8.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:

- `HW8.ipynb`
- `generator_config.yaml`
- `discriminator_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, Union
from tqdm import tqdm
import numpy as np

import matplotlib.pyplot as plt
# plt.rcParams.update({'figure.autolayout': True})
from IPython.display import display, clear_output
```

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

from google.colab import drive
drive.mount('/content/drive')
import os
os.chdir("/content/drive/MyDrive/24789HW8")

from HW8_utils import AirfoilDataset

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 cpu
```

1 Fundamentals of Generative Adversarial Networks (30)

First, you have to answer some questions to validate your knowledge about the fundamentals of GANs. Explain your reasoning for each question, and keep your response concise.

You can also verify your answers by what you observe in the programming section of the assignment.

1.1 QUESTION 1 (10)

For a GAN with a well-balanced generator and discriminator, what should the output of the discriminator be for real data $D(x)$ and fake data $D(G(z))$ in the early iterations of training? How should $D(x)$ and $D(G(z))$ change as the training progresses? (For each case, should it be closer to 0 or 0.5 or 1?)

What would indicate getting close to a successfully trained GAN?

RESPONSE:

In the early stages of training, the generator has almost no fit, and the performance on fake data will be very poor. Therefore, the discriminator will easily identify false data, D(x) will be very close to 1, and D(G(z)) will be very close to 0.

As the training progresses, the generator gradually learns, and the generated data gradually approaches the training samples. Ideally, both D(x) and D(G(z)) will converge towards 0.5. If D(x) and D(G(z)) both stabilize at 0.5 at the end of the training, then the GAN training is perfect.

1.2 QUESTION 2 (10)

Assume you have started training a GAN, and you observe in the early iterations that the generator and discriminator losses are similar. The output of the discriminator for real and fake data are also similar.

Do you think that the training will be successful and lead to a good GAN capable of generating realistic samples? If not, what is the problem and how could you mitigate it?

RESPONSE:

If the generator and discriminator losses are similar in early iterations, this means that the discriminator has not learned how to distinguish real data from fake data at all. This is a red flag that we may need a wider or deeper discriminator to capture the difference between real and fake data.

1.3 QUESTION 3 (10)

Assume you have started training a GAN, and you observe that the discriminator loss quickly converges to zero, while the generator loss seems unstable or very large even after training for some time. What do you think the discriminator score is for real and fake data?

Do you think that the training will be successful and lead to a good GAN capable of generating realistic samples? If not, what is the problem and how could you mitigate it?

RESPONSE:

Converging the discriminator too quickly during training is also a bad sign. Because this will result in the generator being unable to fool the discriminator and not getting any effective gradient information feedback. Simplifying the discriminator architecture (reduce hidden size), reducing the discriminator learning rate, or using a coefficient of real target * 0.9 (target = torch.ones_like(D_real) * 0.9) are all approaches that can be tried.

2 Implement and train a GAN to generate airfoils (70)

You are provided with the UIUC airfoil dataset consisting of 1547 airfoil profiles. The Dataset class to load the data is provided in `HW8_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.

[2]:
```
airfoil_dataset = AirfoilDataset()
print(f'dataset has {len(airfoil_dataset)} samples')
```

```
dataset has 1547 samples
```

[3]:
```
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
```

2.1 Implement a Generator and a Discriminator (20)

You do not need a complicated architecture for the generator and discriminator in this assignment. You can use the example from the recitation to implement the general architecture, but do not copy the exact models, since there might be details specific to the datasets. Try to implement the models by yourself to get comfortable with defining soft-coded atchutectures.

[4]:
```
# AUTOGRADED

class Generator(nn.Module):

    def __init__(
            self,
            latent_size: int,
            output_size: int,
            hidden_dim: int = 512
            ):
        super().__init__()

        self.latent_size = latent_size

        self.net = nn.Sequential(
            nn.Linear(latent_size, hidden_dim),
            nn.ReLU(inplace=True),
            nn.Linear(hidden_dim, output_size),
            nn.Tanh()
        )

    def forward(
            self,
            z: torch.FloatTensor, # (batch_size, latent_size)
            ) -> torch.FloatTensor: # (batch_size, *output_shape)
        """
        Input z is the latent vector, typically sampled from N(0, I)
        Outputs generated samples
        """
        return self.net(z)

    def generate(
            self,
            n_samples: int,
            device: str = Device,
            ) -> torch.FloatTensor: # (n_samples, output_size)
        """
        move self to the device
        sample n_samples latent vectors from N(0, I)
        generate n_samples samples
        """
```

```
        self.to(device)

        z = torch.randn(n_samples, self.latent_size, device=device)
        return self.forward(z)


class Discriminator(nn.Module):

    def __init__(
            self,
            input_size: int,
            hidden_dim: int = 512

            ):
        super().__init__()

        self.net = nn.Sequential(
            nn.Linear(input_size, hidden_dim),
            nn.LeakyReLU(0.2, inplace=True),
            nn.Linear(hidden_dim, 1),
            nn.Sigmoid()
        )

    def forward(
            self,
            x: torch.FloatTensor, # (batch_size, input_size)
            ) -> torch.FloatTensor: # (batch_size, 1)

        return self.net(x)
```

2.2 Tracking and Visualization

[5]:
```
class GAN_Tracker:
    """
    Logs and plots different loss terms of a GAN during training.
    """
    def __init__(
            self,
            n_iters: int,
            plot_freq: Union[int, None] = None, # plot every plot_freq␣
 ↪iterations
            ):

        self.real_scores = []
        self.fake_scores = []
        self.D_losses = []
        self.G_losses = []
```

```
        self.plot = plot_freq is not None
        self.iter = 0
        self.n_iters = n_iters

        if self.plot:
            self.plot_freq = plot_freq
            self.plot_results()


    def plot_results(self):
        self.fig, (self.ax1, self.ax2) = plt.subplots(1, 2, figsize=(13, 3),␣
↪sharex=True)

        # Score plot:
        self.real_score_curve, = self.ax1.plot(
            range(1, self.iter+1),
            self.real_scores,
                        label = r'$D(x)$',
            )
        self.fake_score_curve, = self.ax1.plot(
            range(1, self.iter+1),
            self.fake_scores,
            label = r'$D(G(z))$',
            )

        self.ax1.set_xlim(0, self.n_iters+1)
        self.ax1.set_ylim(0, 1)
        self.ax1.set_xlabel('Iteration')
        self.ax1.set_ylabel('Discriminator Score')
        self.ax1.set_title('Discriminator Score')
        self.ax1.grid(linestyle='--')
        self.ax1.legend()

        # Loss plot:
        self.D_loss_curve, = self.ax2.plot(
            range(1, self.iter+1),
            self.D_losses,
                        label = 'D',
            )
        self.G_loss_curve, = self.ax2.plot(
            range(1, self.iter+1),
            self.G_losses,
            label = 'G',
            )
        self.ax2.set_xlim(0, self.n_iters+1)
        self.ax2.set_xlabel('Iteration')
```

```
        self.ax2.set_ylabel('Loss')
        self.ax2.set_title('Learning Curve')
        self.ax2.grid(linestyle='--')
        self.ax2.legend()

        self.samples_fig, self.samples_axes = plt.subplots(4, 6, figsize=(12,␣
↪8), sharex=True, sharey=True)
        self.sample_axes = self.samples_axes.flat
        self.samples = []
        for ax in self.sample_axes:
            self.samples.append(ax.plot(airfoil_dataset.get_x(), np.
↪zeros_like(airfoil_dataset.get_x()))[0])
            ax.set_xlim(-0.1, 1.1)
            ax.set_ylim(-0.6, 0.6)
            ax.set_aspect('equal')
            ax.grid(linestyle='--')


    def update(
            self,
            real_score: float,
            fake_score: float,
            D_loss: float,
            G_loss: float,
            ):
        self.real_scores.append(real_score)
        self.fake_scores.append(fake_score)
        self.D_losses.append(D_loss)
        self.G_losses.append(G_loss)
        self.iter += 1

        if self.plot and self.iter % self.plot_freq == 0:

            # score plot:
            self.real_score_curve.set_data(range(1, self.iter+1), self.
↪real_scores)
            self.fake_score_curve.set_data(range(1, self.iter+1), self.
↪fake_scores)
            self.ax1.relim()
            self.ax1.autoscale_view()

            # loss plot:
            self.D_loss_curve.set_data(range(1, self.iter+1), self.D_losses)
            self.G_loss_curve.set_data(range(1, self.iter+1), self.G_losses)
            self.ax2.relim()
            self.ax2.autoscale_view()
```

```
            self.samples_fig.suptitle(f'Generated Samples at Iteration {self.
↪iter}')

            self.fig.canvas.draw()
            clear_output(wait=True)
            display(self.fig)
            display(self.samples_fig)


    def get_samples(
            self,
            samples: torch.FloatTensor, # (n_samples, *output_shape)
            ):
        for sample, sample_img in zip(samples, self.samples):
            sample_img.set_ydata(sample.detach().cpu().numpy())
```

2.3 Losses (15)

Hint: use `F.binary_cross_entropy` with the right input and target.

[6]:
```
def D_real_loss_fn(
        D_real: torch.FloatTensor, # (batch_size, 1)
        ) -> torch.FloatTensor: # ()
    """
    D_real is D(x), the discriminator's output when fed with real images
    We want this to be close to 1, because the discriminator should recognize␣
↪real images
    """
    target = torch.ones_like(D_real)
    return F.binary_cross_entropy(D_real, target)

def D_fake_loss_fn(
        D_fake: torch.FloatTensor, # (batch_size, 1)
        ) -> torch.FloatTensor: # ()
    """
    D_fake is D(G(z)), the discriminator's output when fed with generated images
    We want this to be close to 0, because the discriminator should not be␣
↪fooled
    """
    target = torch.zeros_like(D_fake)
    return F.binary_cross_entropy(D_fake, target)

def G_loss_fn(
        D_fake: torch.FloatTensor, # (batch_size, 1)
        ) -> torch.FloatTensor: # ()
    """
    D_fake is D(G(z)), the discriminator's output when fed with generated images
```

```
    We want this to be close to 1, because the generator wants to fool the␣
↪discriminator
    """
    target = torch.ones_like(D_fake)
    return F.binary_cross_entropy(D_fake, target)
```

2.4 Training (15)

We suggest you avoid copy-pasting from the recitation and try to remember the steps in training a GAN to learn it well. After you implement your solution, compare with the recitation and correct your code accordingly.

[7]:
```
def train_GAN(
        generator: Generator,
        discriminator: Discriminator,
        train_dataset: Dataset,
        device: str = Device,
        plot_freq: int = 100,

        # Generator
        optimizer_name_G: str = 'Adam',
        optimizer_config_G: dict = dict(lr=1e-3),
        lr_scheduler_name_G: Union[str, None] = None,
        lr_scheduler_config_G: dict = dict(),

        # Discriminator
        optimizer_name_D: str = 'Adam',
        optimizer_config_D: dict = dict(lr=1e-3),
        lr_scheduler_name_D: Union[str, None] = None,
        lr_scheduler_config_D: dict = dict(),

        n_iters: int = 10000,
        batch_size: int = 64,
        ):

    generator = generator.to(device)
    discriminator = discriminator.to(device)

    optimizer_G: optim.Optimizer = optim.
↪__getattribute__(optimizer_name_G)(generator.parameters(),␣
↪**optimizer_config_G)
    if lr_scheduler_name_G is not None:
        lr_scheduler_G: lr_scheduler._LRScheduler = lr_scheduler.
↪__getattribute__(lr_scheduler_name_G)(optimizer_G, **lr_scheduler_config_G)
```

```
    optimizer_D: optim.Optimizer = optim.
↪__getattribute__(optimizer_name_D)(discriminator.parameters(),␣
↪**optimizer_config_D)
    if lr_scheduler_name_D is not None:
        lr_scheduler_D: lr_scheduler._LRScheduler = lr_scheduler.
↪__getattribute__(lr_scheduler_name_D)(optimizer_D, **lr_scheduler_config_D)

    train_loader = DataLoader(train_dataset, batch_size=batch_size,␣
↪shuffle=True, drop_last=True)

    tracker = GAN_Tracker(n_iters=n_iters, plot_freq=plot_freq)

    iter_pbar = tqdm(range(n_iters), desc='Training', unit='iter')
    iter = 0

    while iter < n_iters:

        for x_real, _ in train_loader:

            x_real = x_real.to(device)
            n_samples = len(x_real)

            # ============ Train Discriminator ============

            optimizer_D.zero_grad()

            D_real = discriminator(x_real)
            loss_D_real = D_real_loss_fn(D_real)

            z = torch.randn(n_samples, generator.latent_size, device=device)
            x_fake = generator(z).detach()
            D_fake = discriminator(x_fake)
            loss_D_fake = D_fake_loss_fn(D_fake)

            loss_D = loss_D_real + loss_D_fake
            loss_D.backward()
            optimizer_D.step()

            D_real_avg: float = D_real.mean().item() # average output of␣
↪discriminator on real data, for logging
            D_fake_avg: float = D_fake.mean().item() # average output of␣
↪discriminator on fake data, for logging
            D_loss_item: float = loss_D.item() # For logging

            # ============ Train Generator ============

            optimizer_G.zero_grad()
```

```
            z = torch.randn(n_samples, generator.latent_size, device=device)
            x_fake = generator(z)
            D_fake_for_G = discriminator(x_fake)
            loss_G = G_loss_fn(D_fake_for_G)
            loss_G.backward()
            optimizer_G.step()

            if lr_scheduler_name_G is not None:
                lr_scheduler_G.step()

            G_loss_item: float = loss_G.item() # For logging

            # ============ Logging =================
            iter += 1
            iter_pbar.update(1)
            if iter % plot_freq == 0:
                with torch.inference_mode():
                    tracker.get_samples(generator.generate(n_samples=24,␣
↪device=device))
            tracker.update(D_real_avg, D_fake_avg, D_loss_item, G_loss_item)

            if iter >= n_iters:
                break
```

2.5 Find and train a good model (20)

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. A nice airfoil would be an airfoil with a smooth surface. For this dataset, making a GAN work is more tricky than what you experienced with a VAE, so the generated samples may not be as smooth. In the figure below, all samples are considered nice enough except one.

Your grade also depends on the diversity of the generated samples. If all your samples look the same, your GAN is suffering from *mode collapse*, and you will get at most 5 points depending on the quality of the sample. If your samples are diverse but not nice, you will get 0 (garbage), 5 (too bad, but looks like airfoils), 10 (not bad), or 15 (almost there) points depending on how nice they are. The grading will be generously done.

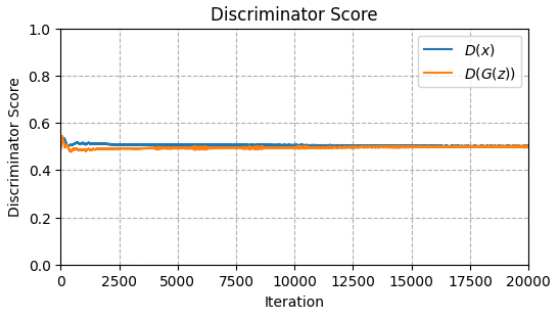
HINT: Think about how to balance the generator and discriminator and stabilize the training as it progresses. You may find using learning rate schedulers useful.

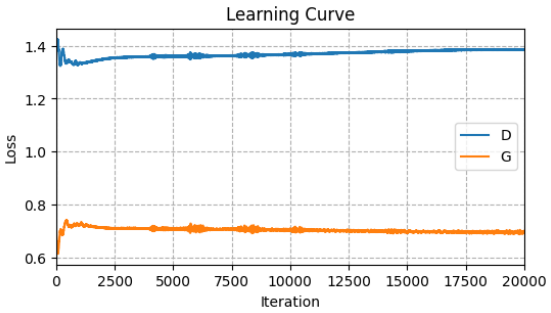
DO NOT CHANGE `input_size` and `latent_size`.

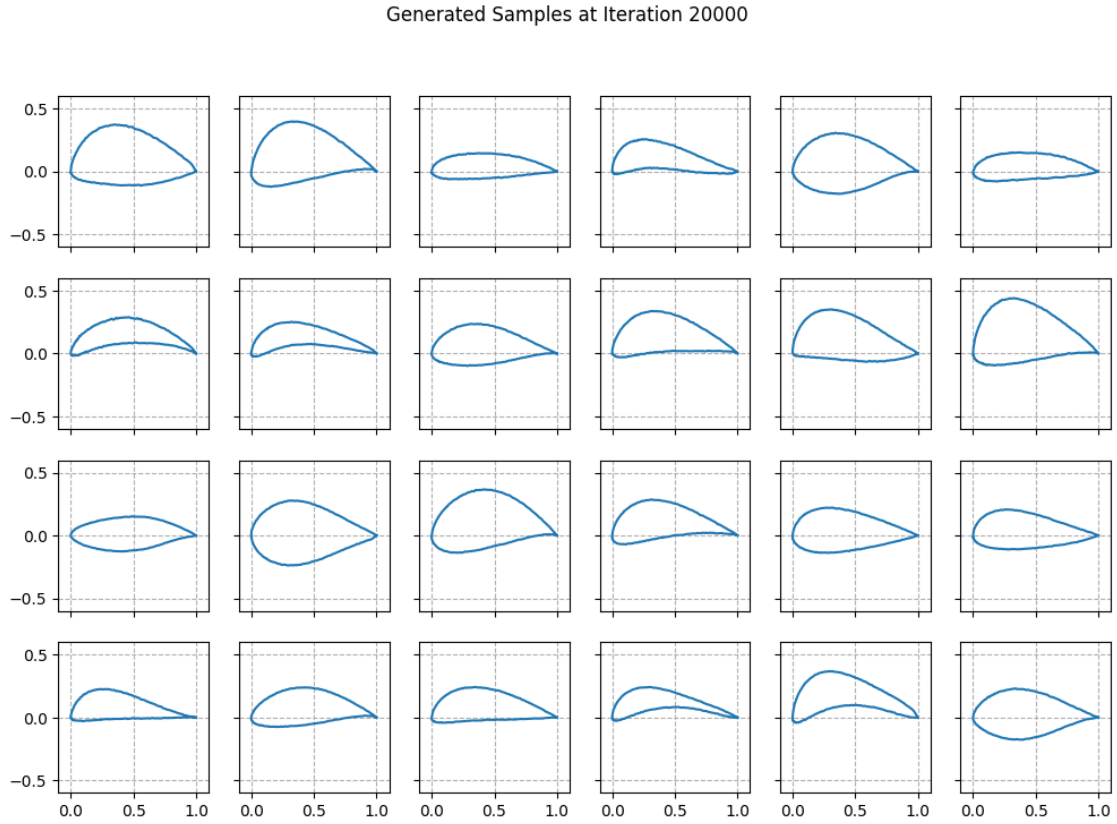
[20]:
```
"""
Choose model and training configuration
```

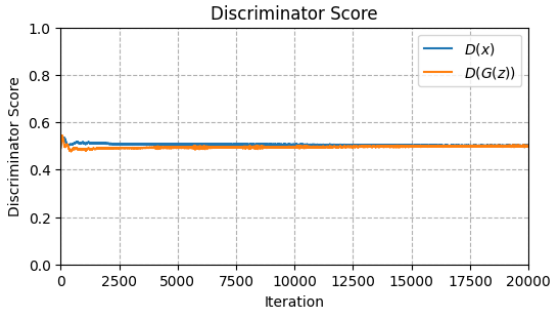
```
"""
input_size = 200 # DO NOT CHANGE
latent_size = 16 # DO NOT CHANGE

generator_config = dict(
    latent_size = latent_size,
    output_size = input_size,
    hidden_dim=512,
    )

discriminator_config = dict(
    input_size = input_size,
    hidden_dim=512,
    )

train_config = dict(
    # Generator
    optimizer_name_G = 'Adam',
    optimizer_config_G = {'lr': 2.75e-5, 'betas': (0.5, 0.999)},
    lr_scheduler_name_G = None,
    lr_scheduler_config_G = dict(),

    # Discriminator
    optimizer_name_D = 'Adam',
    optimizer_config_D = {'lr': 2.25e-5, 'betas': (0.5, 0.999)},
    lr_scheduler_name_D = None,
    lr_scheduler_config_D = dict(),

    n_iters = 20000,
    batch_size = 256,
    )
```

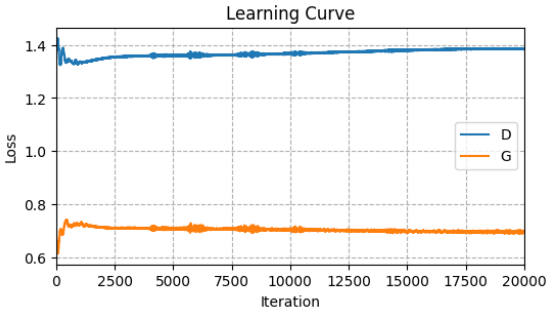
[21]:
```
if __name__ == '__main__':
    generator = Generator(**generator_config)
    discriminator = Discriminator(**discriminator_config)
    train_GAN(
        generator = generator,
        discriminator = discriminator,
        train_dataset = airfoil_dataset,
        device = Device,
        plot_freq = 1000,
        **train_config,
        )
```

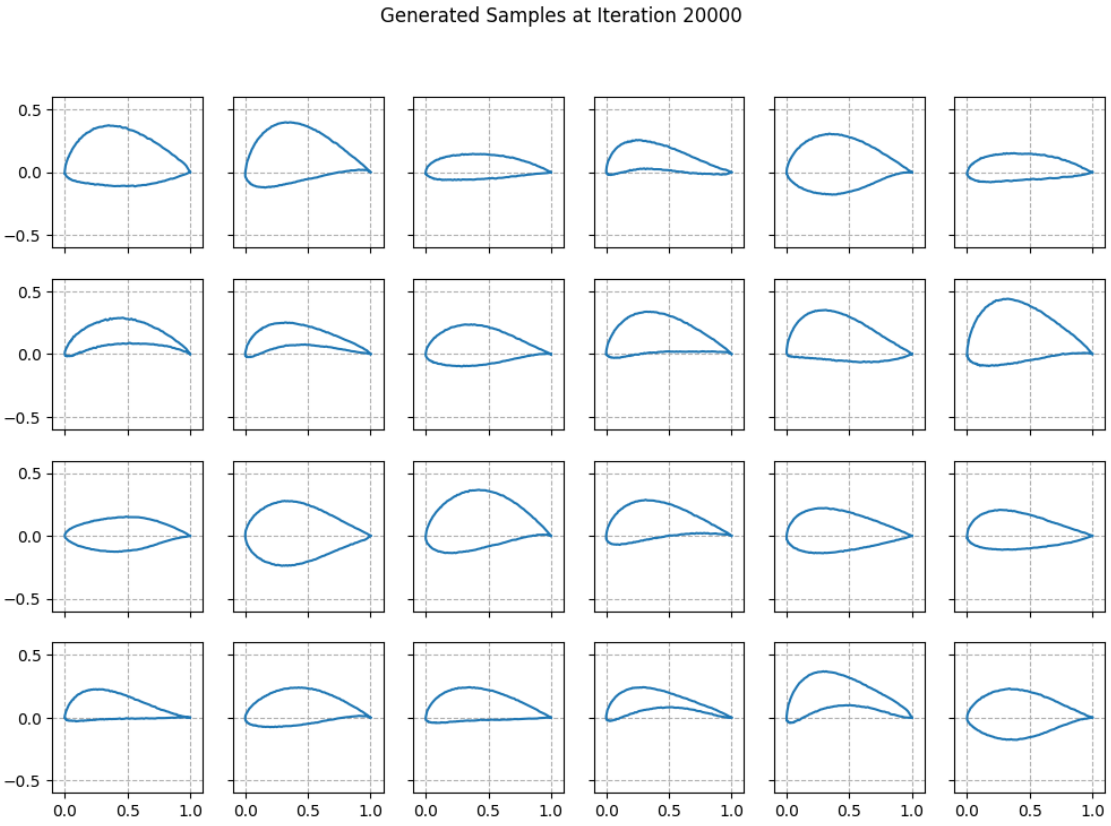

Discriminator Score
Discriminator Score
Iteration
D(x)
D(G(z))


Learning Curve
Loss
Iteration
D
G


Generated Samples at Iteration 20000


Discriminator Score
Discriminator Score
Iteration
D(x)
D(G(z))


Learning Curve
Loss
Iteration
D
G



3 Zip files for submission

[22]:
```
from HW8_utils import save_yaml, zip_files

save_yaml(generator_config, 'generator_config.yaml')
save_yaml(discriminator_config, 'discriminator_config.yaml')
save_yaml(train_config, 'train_config.yaml')

submission_files = ['HW8.ipynb', 'generator_config.yaml', 'discriminator_config.
↪yaml', 'train_config.yaml']
zip_files('HW8_submission.zip', submission_files)
```

[23]:
```
!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 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 libsynctex2
  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 t1utils 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 libsynctex2
  libteckit0 libtexlua53 libtexluajit2 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 t1utils 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~dfsg1-0ubuntu5.10 [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
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
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 4s (56.6 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 …
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 …
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 libsynctex2:amd64.
Preparing to unpack …/32-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 …/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 libzzip-0-13:amd64.
Preparing to unpack …/36-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 …/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 …
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 t1utils.
Preparing to unpack …/43-t1utils_1.41-4build2_amd64.deb …
Unpacking t1utils (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 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 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 libsynctex2: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) …
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/libhwloc.so.15 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/libtbbbind_2_0.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/libtbb.so.12 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/libtbbbind.so.3 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_loader.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/libtbbbind_2_5.so.3 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.
```

[24]:
```
!jupyter nbconvert --to pdf '/content/drive/MyDrive/24789HW8/HW7.ipynb'
```

```
[NbConvertApp] Converting notebook /content/drive/MyDrive/24789HW7/HW7.ipynb to
pdf
Traceback (most recent call last):
  File "/usr/local/bin/jupyter-nbconvert", line 10, in <module>
    sys.exit(main())
             ^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/jupyter_core/application.py",
line 283, in launch_instance
    super().launch_instance(argv=argv, **kwargs)
  File "/usr/local/lib/python3.11/dist-
packages/traitlets/config/application.py", line 992, in launch_instance
    app.start()
  File "/usr/local/lib/python3.11/dist-packages/nbconvert/nbconvertapp.py", line
420, in start
    self.convert_notebooks()
  File "/usr/local/lib/python3.11/dist-packages/nbconvert/nbconvertapp.py", line
597, in convert_notebooks
    self.convert_single_notebook(notebook_filename)
  File "/usr/local/lib/python3.11/dist-packages/nbconvert/nbconvertapp.py", line
563, in convert_single_notebook
    output, resources = self.export_single_notebook(
                        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/nbconvert/nbconvertapp.py", line
487, in export_single_notebook
    output, resources = self.exporter.from_filename(
                        ^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/templateexporter.py", line 390, in from_filename
    return super().from_filename(filename, resources, **kw)  #
type:ignore[return-value]
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/exporter.py", line 201, in from_filename
    return self.from_file(f, resources=resources, **kw)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/templateexporter.py", line 396, in from_file
    return super().from_file(file_stream, resources, **kw)  #
type:ignore[return-value]
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
```

```
packages/nbconvert/exporters/exporter.py", line 220, in from_file
    return self.from_notebook_node(
           ^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/nbconvert/exporters/pdf.py",
line 184, in from_notebook_node
    latex, resources = super().from_notebook_node(nb, resources=resources, **kw)
                       ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/nbconvert/exporters/latex.py",
line 92, in from_notebook_node
    return super().from_notebook_node(nb, resources, **kw)
           ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/templateexporter.py", line 412, in
from_notebook_node
    nb_copy, resources = super().from_notebook_node(nb, resources, **kw)
                         ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/exporter.py", line 154, in from_notebook_node
    nb_copy, resources = self._preprocess(nb_copy, resources)
                         ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/exporter.py", line 355, in _preprocess
    self._validate_preprocessor(nbc, preprocessor)
  File "/usr/local/lib/python3.11/dist-
packages/nbconvert/exporters/exporter.py", line 322, in _validate_preprocessor
    nbformat.validate(nbc, relax_add_props=True)
  File "/usr/local/lib/python3.11/dist-packages/nbformat/validator.py", line
501, in validate
    for error in iter_validate(
  File "/usr/local/lib/python3.11/dist-packages/nbformat/validator.py", line
660, in iter_validate
    errors = _get_errors(nbdict, version, version_minor, relax_add_props)
             ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/nbformat/validator.py", line
515, in _get_errors
    validator = get_validator(version, version_minor,
relax_add_props=relax_add_props)
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/nbformat/validator.py", line 96,
in get_validator
    validators[version_tuple] = current_validator(schema_json)
                                ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/nbformat/json_compat.py", line
63, in __init__
    self._validator = fastjsonschema.compile(schema)
                      ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/usr/local/lib/python3.11/dist-packages/fastjsonschema/__init__.py",
line 217, in compile
```

```
    exec(code_generator.func_code, global_state)
  File "<string>", line 0, in <module>
KeyboardInterrupt
^C
```