Installing the dataset from kaggle

In [ ]:
```
!pwd
```

```
/content
```

In [ ]:
```
!pip install kaggle
```

```
Requirement already satisfied: kaggle in /usr/local/lib/python3.10/dist-packages (1.6.1
4)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.10/dist-packages (fro
m kaggle) (1.16.0)
Requirement already satisfied: certifi>=2023.7.22 in /usr/local/lib/python3.10/dist-pack
ages (from kaggle) (2024.6.2)
Requirement already satisfied: python-dateutil in /usr/local/lib/python3.10/dist-package
s (from kaggle) (2.8.2)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from
kaggle) (2.31.0)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from kag
gle) (4.66.4)
Requirement already satisfied: python-slugify in /usr/local/lib/python3.10/dist-packages
(from kaggle) (8.0.4)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.10/dist-packages (from
kaggle) (2.0.7)
Requirement already satisfied: bleach in /usr/local/lib/python3.10/dist-packages (from k
aggle) (6.1.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.10/dist-packages
(from bleach->kaggle) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in /usr/local/lib/python3.10/dist-pac
kages (from python-slugify->kaggle) (1.3)
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dis
t-packages (from requests->kaggle) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages
(from requests->kaggle) (3.7)
```

In [ ]:
```
!kaggle datasets download -d jessicali9530/celeba-dataset
```

```
Dataset URL: https://www.kaggle.com/datasets/jessicali9530/celeba-dataset
License(s): other
Downloading celeba-dataset.zip to /content
100% 1.33G/1.33G [00:19<00:00, 56.2MB/s]
100% 1.33G/1.33G [00:19<00:00, 74.4MB/s]
```

In [ ]:
```
!pip install tensorflow_docs
```

```
Collecting tensorflow_docs
  Downloading tensorflow_docs-2024.2.5.73858-py3-none-any.whl (182 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 182.5/182.5 kB 3.8 MB/s eta 0:00:00
Collecting astor (from tensorflow_docs)
  Downloading astor-0.8.1-py2.py3-none-any.whl (27 kB)
Requirement already satisfied: absl-py in /usr/local/lib/python3.10/dist-packages (from
 tensorflow_docs) (1.4.0)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.10/dist-packages (from t
ensorflow_docs) (3.1.4)
Requirement already satisfied: nbformat in /usr/local/lib/python3.10/dist-packages (from
 tensorflow_docs) (5.10.4)
Requirement already satisfied: protobuf>=3.12 in /usr/local/lib/python3.10/dist-packages
 (from tensorflow_docs) (3.20.3)
Requirement already satisfied: pyyaml in /usr/local/lib/python3.10/dist-packages (from t
ensorflow_docs) (6.0.1)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-package
s (from jinja2->tensorflow_docs) (2.1.5)
```

```
Requirement already satisfied: fastjsonschema>=2.15 in /usr/local/lib/python3.10/dist-packages (from nbformat->tensorflow_docs) (2.19.1)
Requirement already satisfied: jsonschema>=2.6 in /usr/local/lib/python3.10/dist-packages (from nbformat->tensorflow_docs) (4.19.2)
Requirement already satisfied: jupyter-core!=5.0.*,>=4.12 in /usr/local/lib/python3.10/dist-packages (from nbformat->tensorflow_docs) (5.7.2)
Requirement already satisfied: traitlets>=5.1 in /usr/local/lib/python3.10/dist-packages (from nbformat->tensorflow_docs) (5.7.1)
Requirement already satisfied: attrs>=22.2.0 in /usr/local/lib/python3.10/dist-packages (from jsonschema>=2.6->nbformat->tensorflow_docs) (23.2.0)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in /usr/local/lib/python3.10/dist-packages (from jsonschema>=2.6->nbformat->tensorflow_docs) (2023.12.1)
Requirement already satisfied: referencing>=0.28.4 in /usr/local/lib/python3.10/dist-packages (from jsonschema>=2.6->nbformat->tensorflow_docs) (0.35.1)
Requirement already satisfied: rpds-py>=0.7.1 in /usr/local/lib/python3.10/dist-packages (from jsonschema>=2.6->nbformat->tensorflow_docs) (0.18.1)
Requirement already satisfied: platformdirs>=2.5 in /usr/local/lib/python3.10/dist-packages (from jupyter-core!=5.0.*,>=4.12->nbformat->tensorflow_docs) (4.2.2)
Installing collected packages: astor, tensorflow_docs
Successfully installed astor-0.8.1 tensorflow_docs-2024.2.5.73858
```

Importing libraries plus unzipping the dataset

In [ ]:
```
import glob
import imageio
import matplotlib.pyplot as plt
import numpy as np
import os
import PIL
import tensorflow as tf
from tensorflow.keras import layers
import time

from IPython import display
```

In [ ]:
```
!unzip celeba-dataset.zip
```

```
Streaming output truncated to the last 5000 lines.
  inflating: img_align_celeba/img_align_celeba/197605.jpg
  inflating: img_align_celeba/img_align_celeba/197606.jpg
  inflating: img_align_celeba/img_align_celeba/197607.jpg
  inflating: img_align_celeba/img_align_celeba/197608.jpg
  inflating: img_align_celeba/img_align_celeba/197609.jpg
  inflating: img_align_celeba/img_align_celeba/197610.jpg
  inflating: img_align_celeba/img_align_celeba/197611.jpg
  inflating: img_align_celeba/img_align_celeba/197612.jpg
  inflating: img_align_celeba/img_align_celeba/197613.jpg
  inflating: img_align_celeba/img_align_celeba/197614.jpg
  inflating: img_align_celeba/img_align_celeba/197615.jpg
  inflating: img_align_celeba/img_align_celeba/197616.jpg
  inflating: img_align_celeba/img_align_celeba/197617.jpg
  inflating: img_align_celeba/img_align_celeba/197618.jpg
  inflating: img_align_celeba/img_align_celeba/197619.jpg
  inflating: img_align_celeba/img_align_celeba/197620.jpg
  inflating: img_align_celeba/img_align_celeba/197621.jpg
  inflating: img_align_celeba/img_align_celeba/197622.jpg
  inflating: img_align_celeba/img_align_celeba/197623.jpg
  inflating: img_align_celeba/img_align_celeba/197624.jpg
  inflating: img_align_celeba/img_align_celeba/197625.jpg
  inflating: img_align_celeba/img_align_celeba/197626.jpg
  inflating: img_align_celeba/img_align_celeba/197627.jpg
  inflating: img_align_celeba/img_align_celeba/197628.jpg
  inflating: img_align_celeba/img_align_celeba/197629.jpg
```

```
  inflating: img_align_celeba/img_align_celeba/202580.jpg
  inflating: img_align_celeba/img_align_celeba/202581.jpg
  inflating: img_align_celeba/img_align_celeba/202582.jpg
  inflating: img_align_celeba/img_align_celeba/202583.jpg
  inflating: img_align_celeba/img_align_celeba/202584.jpg
  inflating: img_align_celeba/img_align_celeba/202585.jpg
  inflating: img_align_celeba/img_align_celeba/202586.jpg
  inflating: img_align_celeba/img_align_celeba/202587.jpg
  inflating: img_align_celeba/img_align_celeba/202588.jpg
  inflating: img_align_celeba/img_align_celeba/202589.jpg
  inflating: img_align_celeba/img_align_celeba/202590.jpg
  inflating: img_align_celeba/img_align_celeba/202591.jpg
  inflating: img_align_celeba/img_align_celeba/202592.jpg
  inflating: img_align_celeba/img_align_celeba/202593.jpg
  inflating: img_align_celeba/img_align_celeba/202594.jpg
  inflating: img_align_celeba/img_align_celeba/202595.jpg
  inflating: img_align_celeba/img_align_celeba/202596.jpg
  inflating: img_align_celeba/img_align_celeba/202597.jpg
  inflating: img_align_celeba/img_align_celeba/202598.jpg
  inflating: img_align_celeba/img_align_celeba/202599.jpg
  inflating: list_attr_celeba.csv
  inflating: list_bbox_celeba.csv
  inflating: list_eval_partition.csv
  inflating: list_landmarks_align_celeba.csv
```

Importing first 500 images and normalizing it

So this section was quite interesting to play. At first I just took all the images of the dataset and literally colab died. My RAM was as high as 12 GB. Then I tried decreasing the size so I brought it down to I guess 50000 images and it was still taking some 10 minutes per epoch(total epochs were 50). I trained my model whole night and got some not so good but not so bad results. It took nearly 7 hours to train. So I decreased the size further to 500 images. Now training time was reduced to 40 secs. I got similar results so that was an achievement. 

This was when I trained with 50k images.

This was at 500 images before changing other parameters.

Also I played with batch size a lot too. Earlier it was 256 which I shamelessly copied from mnist tf implementation. But It was not working. I tried to decrease it. Changed it couple of times and got to know that 32 to 64 is good range for the model.

In [ ]:
```
all_image_path = []
full_image_train_path = '/content/img_align_celeba/img_align_celeba'
for path in os.listdir(full_image_train_path):
  if '.jpg' in path:
    all_image_path.append(os.path.join(full_image_train_path, path))
image_path_50k = all_image_path[0:500]
len(image_path_50k)
```

Out[ ]:
```
500
```

In [ ]:
```
from PIL import Image
training_images = [np.array((Image.open(path)).resize((64,64))) for path in image_path_5
```

In [ ]:
```
for i in range(len(training_images)):
  training_images[i] = tf.cast(training_images[i], tf.float32)
  training_images[i] = (training_images[i] / 127.5) - 1.0
  #training_images[i] = ((training_images[i] - training_images[i].min())/(255 - training

training_images = np.array(training_images)
```

In [ ]:
```
buffer_size = 100
batch_size = 32
train_dataset = tf.data.Dataset.from_tensor_slices(training_images).shuffle(buffer_size)
```

Defining generator model for both versions

I didn't try increasing or decreasing layers a lot but I played with kernels, strides and channels a lot. It wasn't changing the output by huge difference but was changing the time/epoch. I tried increasing transpose conv layers till 5 but imo it was't worth it cuz it was taking more time with not so better output. So I kept it 4 and 3 only. Also I tried randomly relu plus dropout but didn't work out.

There are two versions here. V1 is with less conv layers(3) and V2 with more(4). Although Discriminator is same for both the versions

In [ ]:
```
def make_generator_model_v1():
    model = tf.keras.Sequential()
```

```
    model.add(layers.Dense(8*8*512, use_bias=False, input_shape=(100,)))
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Reshape((8, 8, 512)))
    assert model.output_shape == (None, 8, 8, 512)

    model.add(layers.Conv2DTranspose(256, (4, 4), strides=(2, 2), padding='same', use_bi
    assert model.output_shape == (None, 16, 16, 256)
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Conv2DTranspose(64, (5, 5), strides=(2, 2), padding='same', use_bia
    assert model.output_shape == (None, 32, 32, 64)
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Conv2DTranspose(3, (5, 5), strides=(2, 2), padding='same', use_bias
    assert model.output_shape == (None, 64, 64, 3) #matching the size with input image
    return model
```

In [ ]:

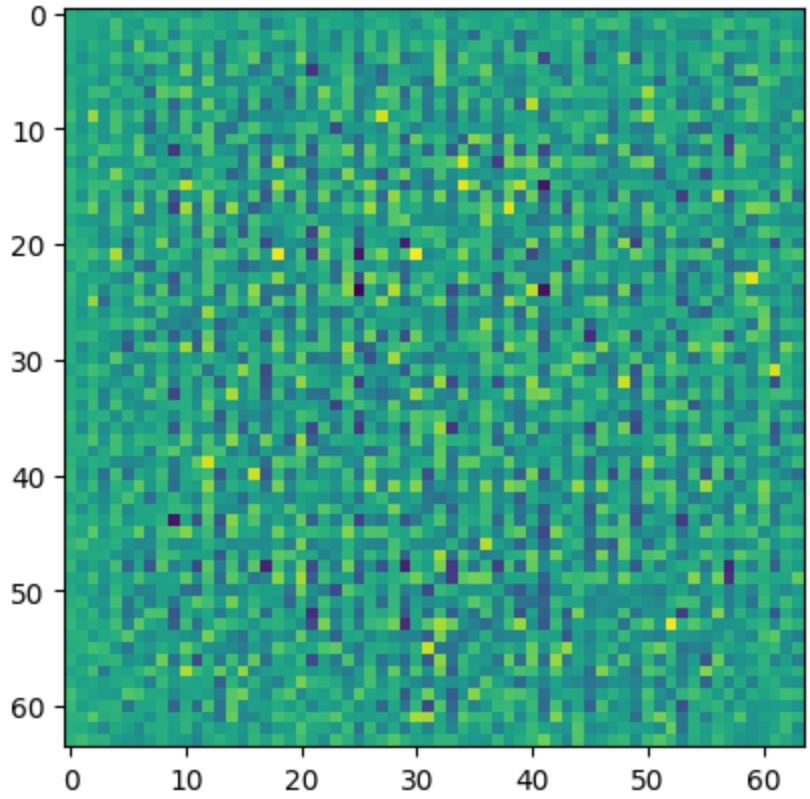
```
def make_generator_model_v2():
    model = tf.keras.Sequential()
    model.add(layers.Dense(8*8*512, use_bias=False, input_shape=(100,)))
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Reshape((8, 8, 512)))
    assert model.output_shape == (None, 8, 8, 512)

    model.add(layers.Conv2DTranspose(256, (4, 4), strides=(2, 2), padding='same', use_bi
    assert model.output_shape == (None, 16, 16, 256)
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Conv2DTranspose(128, (5, 5), strides=(1, 1), padding='same', use_bi
    assert model.output_shape == (None, 16, 16, 128)
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Conv2DTranspose(64, (5, 5), strides=(2, 2), padding='same', use_bia
    assert model.output_shape == (None, 32, 32, 64)
    model.add(layers.BatchNormalization())
    model.add(layers.LeakyReLU())

    model.add(layers.Conv2DTranspose(3, (5, 5), strides=(2, 2), padding='same', use_bias
    assert model.output_shape == (None, 64, 64, 3)

    return model
```

In [ ]:

```
generator_v1 = make_generator_model_v1()
generator_v2 = make_generator_model_v2()

noise = tf.random.normal([1, 100])
generated_image = generator_v2(noise, training=False) #testing the generator

plt.imshow(generated_image[0, :, :, 0])
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x7b76f4e20250>
```



Defining Discriminator model

I didn't play with Discriminator a lot. Also it's same for both the versions.

In [ ]:
```
def make_discriminator_model():
    model = tf.keras.Sequential()
    model.add(layers.Conv2D(64, (5, 5), strides=(2, 2), padding='same',
                                     input_shape=[64, 64, 3])) # not changed it a lot. M
    model.add(layers.LeakyReLU())
    model.add(layers.Dropout(0.3))

    model.add(layers.Conv2D(128, (5, 5), strides=(2, 2), padding='same'))
    model.add(layers.LeakyReLU())
    model.add(layers.Dropout(0.3))

    model.add(layers.Flatten())
    model.add(layers.Dense(1))

    return model
```

In [ ]:
```
discriminator_v1 = make_discriminator_model()
discriminator_v2 = make_discriminator_model()

decision = discriminator_v1(generated_image)
print (decision)
```

```
tf.Tensor([[0.00122523]], shape=(1, 1), dtype=float32)
```

In [ ]:
```
cross_entropy = tf.keras.losses.BinaryCrossentropy(from_logits=True)
```

Defining both losses and adam optimizer

This was the most fun section to play with. First I put my both learning rate to be 1e-4. At this lr

Discriminator was overpowering the generator. So I tried doubling LR of Generator but then generator was overpowering the discriminator. Then I divided both by 10. It was sort of working but model wa not converging and most of the times generator was overpowering Discriminator. I did try with 1.5* but was still not working. Then I looked up for the soultion on stack exchange and tried implementing beta in it. It is working rn.

In [ ]:
```
def discloss(real_output, fake_output):
    real_loss = cross_entropy(tf.ones_like(real_output), real_output)
    fake_loss = cross_entropy(tf.zeros_like(fake_output), fake_output)
    totaloss = real_loss + fake_loss
    return totaloss
```

In [ ]:
```
def genloss(fake_output):
  return cross_entropy(tf.ones_like(fake_output), fake_output)
```

In [ ]:
```
genoptimizerv1 = tf.keras.optimizers.Adam(learning_rate=0.0002, beta_1=0.5)
genoptimizerv2 = tf.keras.optimizers.Adam(learning_rate=0.0002, beta_1=0.5)
discoptimizerv1 = tf.keras.optimizers.Adam(learning_rate=0.0001, beta_1=0.5)
discoptimizerv2 = tf.keras.optimizers.Adam(learning_rate=0.0001, beta_1=0.5)
```

Writing checkpoints for saving images

In [ ]:
```
checkpoint_dir = './training_checkpoints'
checkpoint_prefix = os.path.join(checkpoint_dir, "ckpt")
checkpoint = tf.train.Checkpoint(
    generator_optimizer_v1=genoptimizerv1,
    discriminator_optimizer_v1=discoptimizerv1,
    generator_v1=generator_v1,
    discriminator_v1=discriminator_v1,
    generator_optimizer_v2=genoptimizerv2,
    discriminator_optimizer_v2=discoptimizerv2,
    generator_v2=generator_v2,
    discriminator_v2=discriminator_v2
)
```

Defining epochs and training function

At first I defined epochs to be as high as 1000. But image was hardly changing after 150-200 epochs. Also the losses would first converge to some value till I guess not more 100 eopchs then after that it will vary a lot. Too much random variation. Image would suddenly go black and then retrieve back to same state. So I decreased my epochs too. But when I decreased my input to 500 and also decreased the learning rates then It was taking time to converge or I should say generating a more rigid image. So for now my epochs are 150.

In [ ]:
```
EPOCHS = 150 # I trained repetitively at 150 epochs thats why in plot below you will see
noise_dim = 100
num_examples_to_generate = 10
'''genoptimizerv1.build(generator_v1.trainable_variables)
discoptimizerv1.build(discriminator_v1.trainable_variables)
genoptimizerv2.build(generator_v2.trainable_variables)
discoptimizerv2.build(discriminator_v2.trainable_variables)'''

all_trainable_variables = generator_v1.trainable_variables + discriminator_v1.trainable_
                          generator_v2.trainable_variables + discriminator_v2.trainable_
```

```
genoptimizerv1.build(all_trainable_variables)
discoptimizerv1.build(all_trainable_variables)
genoptimizerv2.build(all_trainable_variables)
discoptimizerv2.build(all_trainable_variables)

#seed = tf.random.normal([num_examples_to_generate, noise_dim])
```

In [ ]:

```
gen_loss_history_v1 = [] # maintains all the losses of both the versions.
gen_loss_history_v2 = []
disc_loss_history_v1 = []
disc_loss_history_v2 = []
combined_loss_history_v1 = []
combined_loss_history_v2 = []
@tf.function
def train_step(images):
    noise_v1 = tf.random.normal([batch_size, noise_dim]) #training from noise
    noise_v2 = tf.random.normal([batch_size, noise_dim])

    with tf.GradientTape() as gen_tape_v1, tf.GradientTape() as gen_tape_v2, tf.Gradient
      #generated_images = generator(noise, training=True)
      generated_images_v1 = generator_v1(noise_v1, training=True) #generating images fro
      generated_images_v2 = generator_v2(noise_v2, training=True)

      real_output_v1 = discriminator_v1(images, training=True)
      fake_output_v1 = discriminator_v1(generated_images_v1, training=True)
      real_output_v2 = discriminator_v2(images, training=True)
      fake_output_v2 = discriminator_v2(generated_images_v2, training=True)

      gen_loss_v1 = genloss(fake_output_v1)
      disc_loss_v1 = discloss(real_output_v1, fake_output_v1)
      gen_loss_v2 = genloss(fake_output_v2)
      disc_loss_v2 = discloss(real_output_v2, fake_output_v2)

      total_loss_v1 = gen_loss_v1 + disc_loss_v1
      total_loss_v2 = gen_loss_v2 + disc_loss_v2

    gradients_of_generator_v1 = gen_tape_v1.gradient(gen_loss_v1, generator_v1.trainable
    gradients_of_discriminator_v1 = disc_tape_v1.gradient(disc_loss_v1, discriminator_v1

    gradients_of_generator_v2 = gen_tape_v2.gradient(gen_loss_v2, generator_v2.trainable
    gradients_of_discriminator_v2 = disc_tape_v2.gradient(disc_loss_v2, discriminator_v2

    genoptimizerv1.apply_gradients(zip(gradients_of_generator_v1, generator_v1.trainable
    discoptimizerv1.apply_gradients(zip(gradients_of_discriminator_v1, discriminator_v1.

    genoptimizerv2.apply_gradients(zip(gradients_of_generator_v2, generator_v2.trainable
    discoptimizerv2.apply_gradients(zip(gradients_of_discriminator_v2, discriminator_v2.

    return gen_loss_v1, disc_loss_v1, total_loss_v1, gen_loss_v2, disc_loss_v2, total_lo
```

In [ ]:

```
min_total_error_v1 = float('inf')# for calculating minimum total loss to find best image
min_total_error_v2 = float('inf')
min_loss_epoch_v1 = -1
min_loss_epoch_v2 = -1

seed_v1 = tf.random.normal([num_examples_to_generate, noise_dim])
seed_v2 = tf.random.normal([num_examples_to_generate, noise_dim])
def train(dataset, epochs):

  global min_total_error_v1, min_loss_epoch_v1, min_total_error_v2, min_loss_epoch_v2

  for epoch in range(epochs):
    start = time.time()
    gen_loss_epoch_v1 = []
    disc_loss_epoch_v1 = []
```

```
    total_loss_epoch_v1 = []
    gen_loss_epoch_v2 = []
    disc_loss_epoch_v2 = []
    total_loss_epoch_v2 = []

    for image_batch in dataset:
      gen_loss_v1, disc_loss_v1, total_loss_v1, gen_loss_v2, disc_loss_v2, total_loss_v2
      gen_loss_epoch_v1.append(gen_loss_v1) # appends the losses on list whose mean will
      disc_loss_epoch_v1.append(disc_loss_v1)
      total_loss_epoch_v1.append(total_loss_v1)
      gen_loss_epoch_v2.append(gen_loss_v2)
      disc_loss_epoch_v2.append(disc_loss_v2)
      total_loss_epoch_v2.append(total_loss_v2)

    gen_loss_history_v1.append(np.mean(gen_loss_epoch_v1))
    disc_loss_history_v1.append(np.mean(disc_loss_epoch_v1))
    combined_loss_history_v1.append(np.mean(total_loss_epoch_v1))
    gen_loss_history_v2.append(np.mean(gen_loss_epoch_v2))
    disc_loss_history_v2.append(np.mean(disc_loss_epoch_v2))
    combined_loss_history_v2.append(np.mean(total_loss_epoch_v2))

    #print(f'Epoch {epoch + 1}, Gen Loss: {gen_loss_history[-1]}, Disc Loss: {disc_loss_
    display.clear_output(wait=True)
    generate_and_save_images(generator_v1, epochs, seed_v1, 'v1') # saving the images
    generate_and_save_images(generator_v2, epochs, seed_v2, 'v2')
    if combined_loss_history_v1[-1] < min_total_error_v1:
      min_total_error_v1 = combined_loss_history_v1[-1] # for calculating minimum loss
      min_loss_epoch_v1 = epoch + 1

    if combined_loss_history_v2[-1] < min_total_error_v2:
      min_total_error_v2 = combined_loss_history_v2[-1]
      min_loss_epoch_v2 = epoch + 1

    if (epoch + 1) % 15 == 0:
      checkpoint.save(file_prefix = checkpoint_prefix)

    print ('Time for epoch {} is {} sec'.format(epoch + 1, time.time()-start))
    plot_losses(gen_loss_history_v1, disc_loss_history_v1, combined_loss_history_v1, ver
    plot_losses(gen_loss_history_v2, disc_loss_history_v2, combined_loss_history_v2, ver

  plot_losses(gen_loss_history_v1, disc_loss_history_v1, combined_loss_history_v1, versi
  plot_losses(gen_loss_history_v2, disc_loss_history_v2, combined_loss_history_v2, versi


  display.clear_output(wait=True)
  #generate_and_save_images(generator,epochs,seed)
  generate_and_save_images(generator_v1, epochs, seed_v1, 'v1')
  generate_and_save_images(generator_v2, epochs, seed_v2, 'v2')
```

Defining ploting losses and generating image function

In [ ]:

```
import matplotlib.pyplot as plt

def plot_losses(gen_losses, disc_losses, combined_losses, version='v1'):
    plt.figure(figsize=(10, 5))
    plt.plot(gen_losses, label=f'Generator Loss ({version})')
    plt.plot(disc_losses, label=f'Discriminator Loss ({version})')
    plt.plot(combined_losses, label=f'Combined Loss ({version})')
    plt.xlabel('Epoch')
    plt.ylabel('Loss')
    plt.title(f'Training Losses ({version})')
```

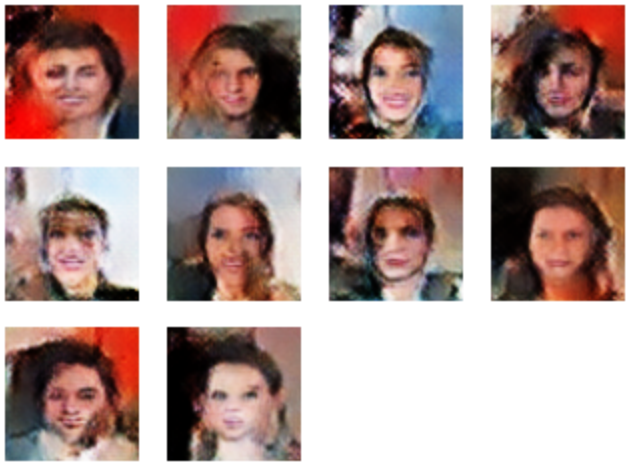
```
    plt.legend()
    plt.grid(True)
    plt.show()
```

In [ ]:
```
def generate_and_save_images(model, epoch, test_input, version):
    predictions = model(test_input, training=False)

    fig = plt.figure(figsize=(4, 4))

    for i in range(predictions.shape[0]):
        plt.subplot(4, 4, i+1)
        plt.imshow((predictions[i] + 1) / 2)
        plt.axis('off')

    plt.savefig(f'image_at_epoch_{epoch:04d}_{version}.png')
    plt.show()
```

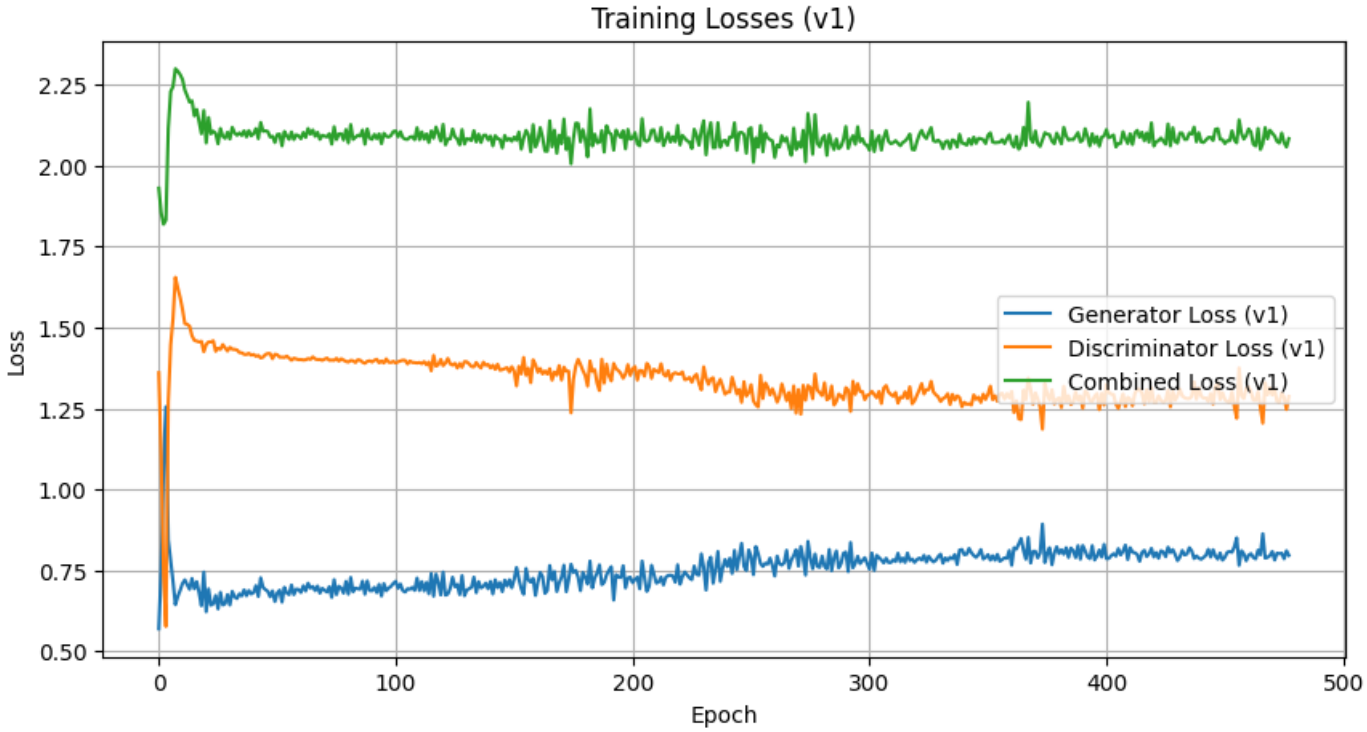
TRAINING THE MODEL

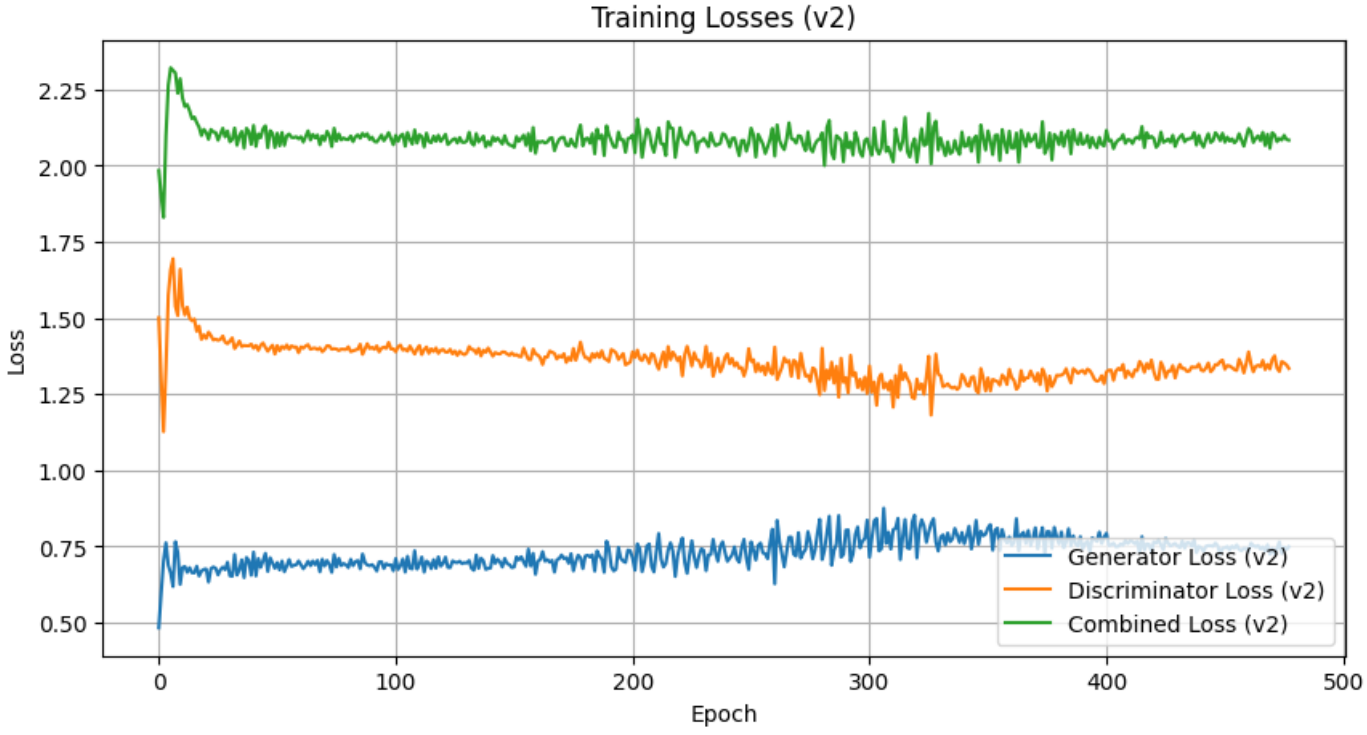
The results I was getting at 180 epochs were the best I guess. After that model went random. I mean few few faces were good in the structure but most of them were random. Here is the one I got at around 150 epochs:

In [ ]:
```
train(train_dataset, EPOCHS)
```



```
Time for epoch 28 is 73.8352587223053 sec
```





In [ ]:
```
plot_losses(gen_loss_history_v1, disc_loss_history_v1, combined_loss_history_v1, version
plot_losses(gen_loss_history_v2, disc_loss_history_v2, combined_loss_history_v2, version
# was not able to plot it cuz runtime used to get disconnected everytime.
```

In [ ]:
```
checkpoint.restore(tf.train.latest_checkpoint(checkpoint_dir))
```

In [ ]:
```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg

# Load and display the image with the lowest loss
image_dir = '/content'
os.makedirs(image_dir, exist_ok=True)

image_path = os.path.join(image_dir, f'image_at_epoch_{min_loss_epoch:04d}.png')
#image_path = 'content/image_at_epoch_{min_loss_epoch:04d}.png'
img = mpimg.imread(image_path)
plt.figure(figsize=(8, 8))
plt.imshow(img)
plt.axis('off')
plt.title(f'Image with Lowest Error at Epoch {min_loss_epoch}')
plt.show()
# was not able to plot it cuz runtime used to get disconnected everytime. I got it at 15
```

In [32]:
```
anim_file = 'dcgan.gif'

with imageio.get_writer(anim_file, mode='I') as writer:
  filenames = glob.glob('image*.png')
  filenames = sorted(filenames)
  for filename in filenames:
    image = imageio.imread(filename)
    writer.append_data(image)
  image = imageio.imread(filename)
  writer.append_data(image)
```

```
<ipython-input-32-56bb6d34be2e>:7: DeprecationWarning: Starting with ImageIO v3 the beha
vior of this function will switch to that of iio.v3.imread. To keep the current behavior
(and make this warning disappear) use `import imageio.v2 as imageio` or call `imageio.v
2.imread` directly.
  image = imageio.imread(filename)
<ipython-input-32-56bb6d34be2e>:9: DeprecationWarning: Starting with ImageIO v3 the beha
vior of this function will switch to that of iio.v3.imread. To keep the current behavior
(and make this warning disappear) use `import imageio.v2 as imageio` or call `imageio.v
2.imread` directly.
  image = imageio.imread(filename)
```

In [33]:
```
import tensorflow_docs.vis.embed as embed
embed.embed_file(anim_file) # this is gif file. The gif currently showing up is for epoc
```

Out[33]:

In [ ]:
```
!pip install tensorflow_docs
```

In [ ]:
```

```